4 ENGINEERING DESIGN

Several types of mine structures and facilities are required to mine phosphate ore and reclaim each respective lease disturbance area within the Project area. These structures include, but are not necessarily limited to, the following:

- Mine pits
- Access haul roads and ramps
- Growth media stockpile areas (GMSAs)
- Pit backfill
- Shop and office
- Temporary and permanent external OSAs
- Staging areas
- Surface water and groundwater management
- Train loading facility (tipple) and ore stockpiles
- Ready line
- Laydown areas
- Fuel storage and containment.

This section of the MRP details the engineering design parameters associated with each of these structures or facilities.

4.1 Surface Disturbance

Ground surface impacts from mining within the lease boundaries include, but are not limited to, the pit, roads, water management features, ready line, lay down areas, and stockpiles. Mining at the site will be a continually evolving process that necessitates flexibility in the placement of these features.

Figure 1-1 shows the location of the pits and associated mine facilities impact area. The pits are depicted as currently designed but may change for various operational and economic reasons through the life of mining. Boundaries around the pits are provided to accommodate other mine facilities, as well as potential changes to pit design. It is impractical to specify the location of each facility as these locations may need to be adjusted to accommodate changes in mining operations. Mining associated impacts within the lease boundaries will occur within the Operational Zone (OZ). Water management within the OZ will be in accordance with the Stormwater Pollution Prevention Plan (SWPPP).

Most of the engineering design structures have an associated surface disturbance as outlined in Table 4-1 and Table 4-2. However, some areas of the Project (such as MCM) were previously disturbed and are not included in the cumulative surface disturbance acreage.

Table 4-1. Husky 1 Surface Disturbance (acres)

Mine Component	Surface Disturbance Area (acres)	Comments
Operational Zone	117	
Husky 1 Mine Pits	376	Includes pits and permanent backfill. 337 acres are forested.
Historical Mine Pits (SMCM)	77	Permanent backfill only
Permanent OSA	55	
Temporary OSA	49	
Proposed Tipple	61	
Proposed Haul Roads	32	
Water Management Ponds, Sediment Control Ponds, Runoff Containment Ponds and Ditches	24	
Streams	20	
Growth Media Stockpile	8	
Total	**819**	

Table 4-2. North Dry Ridge Surface Disturbance (acres)

Mine Component	Surface Disturbance Area (acres)	Comment
Operational Zone	36	
North Dry Ridge Mine Pits	146	Includes pits and permanent backfill. 134 acres are forested.
Historical Mine Pits (NMM)	71	Permanent backfill only
Proposed Tipple	--	Accounted for within H1
Proposed Haul Roads	47	
Water Management Ponds, Sediment Control Ponds, Runoff Containment Ponds and Ditches	15	
Growth Media Stockpile	4	
Ready Line	7	
Total	**326**	

In the design of H1 and NDR, the Idaho Roadless Areas were avoided except for the western portion of the OZ, the permanent OSA located west of the H1 pit, and a portion of the H1 pit in the KPLA. The potential impact to the roadless area would be approximately 16.7 acres with respect to the permanent OSA and 0.2 acre with respect to the H1 pit. Both locations are in General Forest Plan classified roadless areas (Idaho Roadless Rule; USFS undated), which are defined as areas of potential development.

4.1.1 Pit Design Parameters

The H1 and NDR pits will be mined as open pits and sequenced through several phases on each respective site. These pit phases are depicted in Map 6 in Appendix A. Pit design constraints include economic strip ratios, access requirements, slope stability assumptions and requirements, geometrical restrictions for the ultimate pit design, and balancing pit phase volumes with available OSA and backfill volumes. The pit strip ratio may change throughout the mine life depending on many technical factors and market forces. Examples include, but may not be limited to, ore quality, localized slope stability, commodity price, fuel and equipment cost, and other parameters.

Each phase is designed to yield up to approximately 2.4 million wet net ton (WNT) of ore. The floors of the open pits will be designed not to exceed 12 percent grade, where reasonable. Steeper grades may occur where the pit floor can rise very quickly due to localized discontinuity of the deposits, which are interpreted as faults. Often the direction of mining will be used to address access issues. Factors that influence the economic optimal pit size include, but may not be limited to, overburden thickness, ore quality, and estimated value of phosphate ore.

4.1.1.1 Husky 1

H1 will be mined in nine phases over approximately 4.1 miles of strike length. Each phase is designed to yield up to approximately 2.4 million WNT of ore. The H1 pit consists of three general areas – North Area, Central Area and South Area. The average pit widths of each area are – North 950 feet, Central 700 feet and South 1200 feet. The development of the H1 pits, historical mine pits, and ancillary facilities will collectively disturb a total of approximately 818 acres. However, due to progressive open-pit backfilling and concurrent reclamation, the un-reclaimed pit disturbance at any point will be minimized to the extent practical. Refer to Map 3: H1 Ultimate Pit Map in Appendix A.

4.1.1.2 North Dry Ridge

The NDR deposit will be mined in three phases from south to north over approximately 2.0 miles of strike length. Each phase is designed to yield up to approximately 2.4 million WNT of ore. The open pit will be mined to an average width of approximately 715 feet.

The development of the NDR pit, historical mine pits, and ancillary facilities will disturb a total of approximately 322 acres. However, because of progressive open-pit backfilling and concurrent reclamation, the un-reclaimed pit disturbance at any point will be minimized to the extent practical. The Ultimate Pit Map for NDR is shown as Map 10 in Appendix A.

4.1.2 Slope Stability

Slope constraints for the open pits are based on Itafos' experience at nearby mining operations in similar formations. On the footwall side of the deposit, the slope is designed to parallel the dip of the strata where it is shallow. In steeper portions, the overall slope uses a maximum of 48 degrees for a face angle and 30-foot-wide catch benches for each 90 feet of pit depth. This results in a maximum overall slope angle of 45 degrees. Hanging wall slopes in the Rex Chert have been designed using a 48-degree face angle with 20-foot-wide catch benches for every 80 feet of depth. This creates an overall hanging wall slope of 40 degrees. Itafos will perform a future slope stability study to determine more accurate slope design parameters. The same pit design parameters were used for both H1 and NDR. Localized conditions within the pit may require additional layback of the pit walls for safety.

4.1.3 Ore Recovery

Pit configuration and design for both H1 and NDR pits may vary as the mining progresses. In the event of changing economic conditions, slope stability problems, geologic anomalies, or other unforeseeable factors, Itafos may adjust the pit configuration and design parameters.

The open-pit designs were used in conjunction with the resource model to estimate the total anticipated overburden and mineralized material contained in the open pits. Table 4-3 and Table 4-4 show certain details for the ore and depict overburden material values by classification and pit phase for H1 and NDR, respectively.

The following sections summarize ore recovery processes and estimates for the H1 and NDR.

4.1.3.1 Husky 1

The proposed open pits are designed to operate to produce approximately 2.4 million WNT of ore per year during steady-state operations at H1. Annual overburden production will vary over the life of the H1 mining operations but will result in an overall average stripping ratio of approximately 3.6 bank cubic yards (bcy) per WNT of ore. Based on a production rate of 2.4 million WNT of ore per year and a total recovery of 21.4 million WNT, the estimated life of the proposed H1 mining operations will be approximately 11 years; including partial peak production in the first year when transitioning operations from the Rasmussen Valley Mine to the H1 Lease.

Table 4-3. Husky 1 Open Pit Material Quantities (by Phase)

Phase	Ore (WNT)	Overburden (bcy)				
		Dinwoody Formation	Chert	Center Waste Shale	Limestone	Overburden Total
1	2,314,990	540,196	5,239,090	3,707,905	267	9,487,458
2	2,420,998	319,943	5,198,606	3,762,805	-	9,281,354
3	2,379,884	20,528	3,835,598	4,452,123	-	8,308,249

Phase	Ore (WNT)	Overburden (bcy)				
		Dinwoody Formation	Chert	Center Waste Shale	Limestone	Overburden Total
4	2,429,292	114,278	1,332,066	4,684,716	464,689	6,595,749
5	2,412,919	149,710	2,235,890	4,671,393	1,134,718	8,191,711
6	2,354,187	55,391	1,267,979	6,507,149	315,894	8,146,413
7	2,357,813	109,491	2,929,103	5,870,636	527,007	9,436,237
8	2,348,210	184,722	1,322,604	6,617,149	971,484	9,095,959
9	2,330,949	148,291	1,408,720	5,413,191	915,657	7,885,859
Total	**21,349,242**	**1,642,550**	**24,769,656**	**45,687,067**	**4,329,716**	**76,428,989**

4.1.3.2 North Dry Ridge

The proposed open pits are designed to operate at approximately 2.4 million WNT of ore per year during steady-state operations. Annual overburden production will vary over the life of NDR operations but will result in an overall average stripping ratio of approximately 4.1 bcy per WNT of ore. Based on a production rate of 2.4 million wet tons of ore per year and a total recovery of 6.1 million wet tons, the estimated life of the proposed NDR will be approximately 3.5 years considering partial peak production in the first year when transitioning operations from the H1 Lease to the NDR Lease.

Table 4-4. North Dry Ridge Open Pit Material Quantities (by Phase)

Phase	Ore (WNT)	Overburden (bcy)				
		Dinwoody Formation	Chert	Center Waste Shale	Limestone	Overburden Total
10	2,458,649	3,630	2,043,831	5,274,335	3,962,480	11,284,276
11	2,320,380	2,373	1,478,992	4,453,022	3,572,874	9,507,261
12	1,372,800	N/A	428,145	2,007,197	2,193,096	4,628,438
Total	**6,151,829**	**6,003**	**3,950,968**	**11,734,554**	**9,728,450**	**25,419,975**

4.1.4 Access and Haul Road Design

Access or haul roads to the open pits are designed with 80-foot widths for 100-ton-capacity haul trucks allowing for a running surface and a safety berm.

In-pit roads and ramps will be constructed throughout mining. In-pit roads and ramps are subject to frequent change or modifications to meet operational needs; therefore, it is not practical to depict them in detail.

All access and haul roads external to the pits are designed to minimize surface and natural resource impacts and to ensure maximum efficiency and safety in truck haulage. Engineering features of the road designs include the following:

- Road locations will minimize wetland and riparian area disturbance.
  - Road cut slopes will be designed with a 1:1 or 45-degree angle.
  - Road fill slopes will be designed at a repose angle of approximately 36 degrees.
- Road surfaces will be graded to minimize standing water.
- If necessary, large fill or cut slopes may be hydro-mulched, seeded, or otherwise stabilized to prevent excessive soil erosion from runoff.
- Growth media (GM) will be salvaged from the proposed road areas in accordance with Section 4.1.10 and Section 5.6.9.
- Best management practices (BMPs), such as sediment control fencing, straw waddles, and erosion mats, will be used as needed to minimize impacts around haul roads.

Haul road widths may vary based on local physical constraints. Initial construction may necessitate a narrower single-lane haul road until sufficient quantities and quality of material are available to construct a full road width. As discussed in Section 5.2.7, selective overburden material will be used for all haul road construction needs external to the H1 and NDR pits.

Itafos proposes to improve and use the existing historical MCM haul roads. The example cross-sections of these haul roads are presented on Figure 4-1 and Figure 4-2 below.

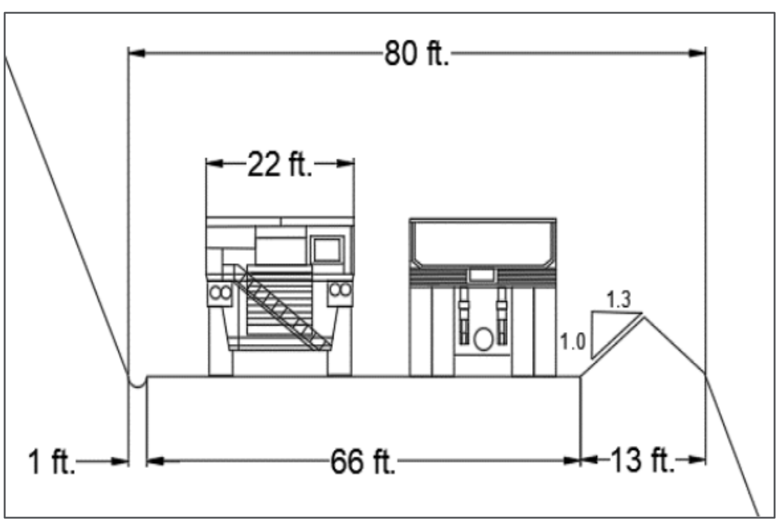


Figure 4-1. Example Double-Lane Design for 100-Ton Class Haul Truck

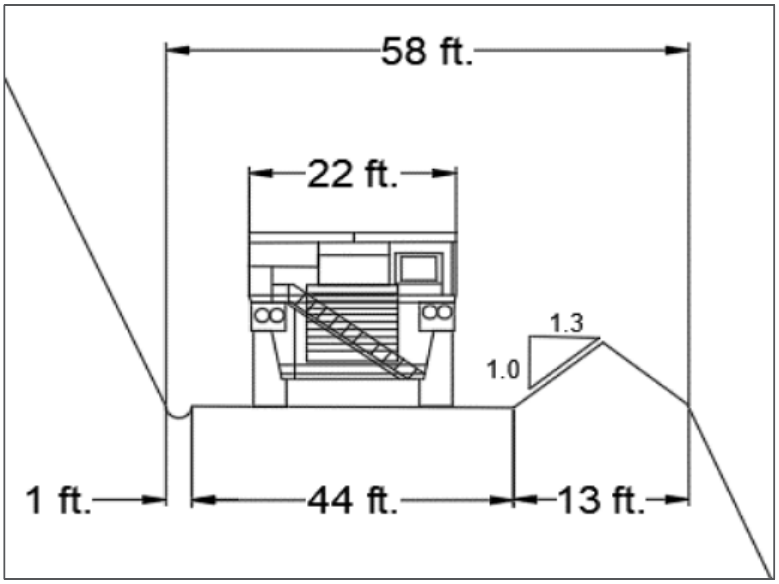


Figure 4-2. Example Single-Lane Design for 100-Ton Class Haul Truck

Haul roads are sized to an 80-foot width, which includes a 10-foot safety berm. As most of the roads will be on steep terrain, haul roads will generally need only one berm on the outside shoulder. The minimal road widths are a result of the steep terrain as well as efforts to minimize impacts. The improvements to the existing roads will rehabilitate and widen the road to a total width of 80 feet by removing cut slope ravel, removing oversized water control ditches, and reconditioning berms as needed. Estimated new disturbances associated with haul road improvements are shown in Table 4-1 and Table 4-2, respectively, for H1 and NDR.

Several external haul roads will be required throughout the life of the mine to haul overburden, GM, and ore. All roads will be constructed with a cut-fill, full cut, and/or full fill method. Any fill construction will use selective materials with side berms where necessary for safety.

Most access and haul road-related disturbance will be reclaimed at the end of mining as part of the comprehensive reclamation plan described in Section 5.6.

4.1.5 Culverts

This section is provided for reference only. Detailed design discussion of culverts and maps showing proposed culvert locations are provided in Appendix D.

Surface water runoff will be conveyed under the access and haul roads through culverts. Culverts are considered long-term or permanent structures; therefore, they were designed to convey the peak discharge from a design storm event selected based on the anticipated life of the culvert installation, as presented in Table 4-5.

Table 4-5. Design Storm Criteria for Peak Flow Conveyance

Anticipated Life of Structure	Design Storm Event[1]
Less than 2 years, or approximately one phase of mining	10-year, 24-hour
2 to 25 years, or multiple mining phases	50-year, 24-hour
Long-term or permanent	100-year, 24-hour

Note:
[1] Appendix D includes maps showing the proposed culvert locations, a description of the conceptual design, and tabulated hydraulic design parameters.

4.1.6 Water Management

This section summarizes management of contact and noncontact surface water, and Appendix D provides the complete Surface Water Management Plan.

Surface water management will consist of managing water based on its potential for transporting constituents of potential concern (COPCs). COPCs are detailed in various permitting documents and will not be repeated in detail here.

In general, surface water will be managed to effectively segregate “contact water” from “noncontact water,” with the goal of preventing discharge of “contact water.”

The following water will be classified as contact water:

- Surface water that comes into contact with waste that, based on both historical data and the site-specific geochemistry program, has a higher potential of containing leachable COPCs (Section 5.2.2), most notably selenium
- Water that mixes with water identified above
- Water that has collected in the pit
- Water collected from the running surfaces of haul roads.

The following water will be classified as noncontact water:

- Surface water that only comes into contact with waste with a historically lower potential of containing leachable COPCs (Section 5.2.2)
- Run-on water diverted around mining disturbances.

Specific control measures and BMPs will be developed in a site-specific SWPPP, which Itafos will develop in accordance with the Idaho Pollutant Discharge Elimination System. Contact water will be managed under the site SWPPP for zero discharge to surface waters from the site. Noncontact water will also be managed under the site SWPPP.

Groundwater is not anticipated to be encountered in sufficient quantity to require special handling. Small perched aquifers may be encountered during mining. These will be allowed to drain to the pit and will be managed as contact water.

4.1.7 Backfill Design

Backfill for the Project was designed using the following basic criteria:

- Backfill should cover all highwalls.
- Backfill grading should shed water off the backfilled pit areas.
- Maximum final backfill grading should be 3:1 (horizontal:vertical).
- Minimum final backfill grading should be 2 percent.
- The permanent OSA should serve as a stable west bank for Maybe Creek and Stewart Creek. This configuration will create a new valley bottom.
- Water infiltrating permanent OSAs will drain subgrade to the mined-out pits and does not express to the surface.
- Areas of un-reclaimed pit wall portions of the pits should be minimized.
- Optimize size of permanent OSA.
- As practical, backfill grading is intended to blend with the surrounding topography and re-establish disrupted drainage patterns across backfill.

Backfill will be placed in two methods. Overburden may be end-dumped from the pit crest or dumped in lifts. Lift heights will be determined on many factors including, but not limited to, safety considerations and the material’s repose slope stability characteristics.

4.1.8 Cap and Cover Design

In this MRP, the term “cap” refers to material placed over the top of run-of-mine (ROM) overburden but is not intended to include a GM layer for revegetation. The term “cover” refers to GM placed over a cap or other disturbances as a substrate to support revegetation as part of reclamation.

Mine site areas that require a cap and cover are the ROM backfill areas (backfilled mine waste, former mine pit areas, and the permanent OSA). Areas that require only a cover include disturbed areas associated with the mine such as haul and access road areas, borrow areas, select surface water management features, and other facilities not associated with ROM backfill.

This cap and cover design assumes use of locally available natural soil and material that will protect water resources.

Itafos is proposing a cap and cover configuration consisting of a minimum 12-inch thickness of GM, overlying a minimum 36-inch thickness of low-seleniferous waste (SeW; Section 5.2.2). The typical section is shown on Figure 4-3 below.

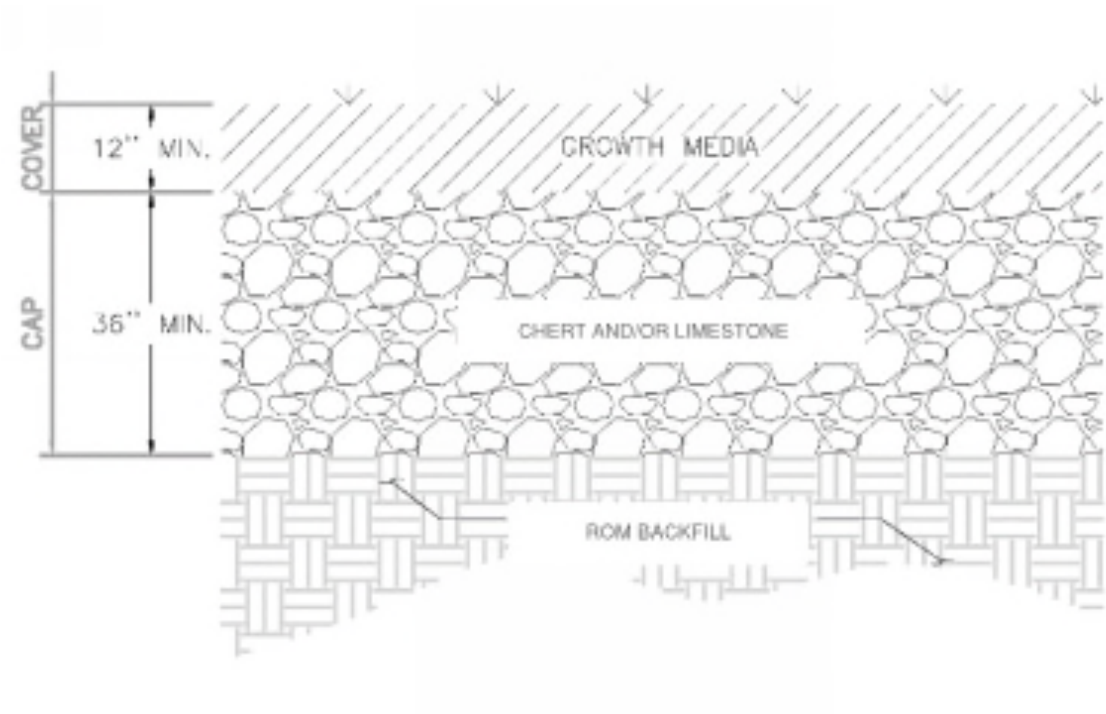


Figure 4-3. Typical Cap and Cover Cross-Section

Covers over areas other than backfill, such as haul and access road areas, borrow areas, and select surface water management features, will consist of a minimum 12-inch thickness of GM only. See Section 5.6.3 for additional detail on reclamation.

The cap and cover were designed to address potential impacts to water resources by incorporating the results of geochemistry and groundwater modeling evaluations. The geochemical and groundwater modeling evaluations are provided in separate submittals.

Appendix F contains the Cap and Cover Design Calculations.

4.1.9 Overburden Storage Area Design

The following sections provide a summary of OSA design and capacities for the H1 and NDR pits. The External OSA Technical Memorandum (Arcadis 2020) has been submitted to provided additional details on the proposed OSA.

4.1.9.1 Husky 1

One temporary OSA will be placed near the southeast end of the H1 Lease. The temporary OSA is needed due to limited capacity of the H1 pit during mining for concurrent reclamation. All material placed in the temporary OSA will be re-handled and placed into the southernmost H1 pits before mine reclamation begins. The temporary OSA will be constructed of ROM material and placed to angle of repose. Water management will be in accordance with the SWPPP and runoff will be managed as contact water.

One permanent OSA will be developed as part of the H1 mining activities. A permanent OSA is necessary for two reasons; it serves to buttress the west bank of the re-aligned Maybe Creek and the lack of initial early mine phase open-pit backfill space.

Section 4.1.7 and 4.1.8 provide design parameters for the OSAs.

4.1.9.2 North Dry Ridge

No OSAs will be required at the NDR Lease.

4.1.10 Growth Media Stockpile Design and Capacities

When direct placement of salvaged GM is not practical, Itafos will stockpile GM salvaged during operations for use in reclamation. GMSAs located on historical backfill areas (i.e., the NDR GMSA) will be constructed with 2 feet of limestone as a base. GMSAs located on native ground will be placed directly on native ground once clearing and grubbing is completed. GMSAs will be within the OZ as well as indicated on figures and maps. While not practical to store all GM in a single GMSA for H1 and NDR, GM will be stored in the fewest GMSAs as efficient. GMSAs are being considered on or in close proximity to certain NMM and SMCM Operational Units (OUs). In these cases, discussions with Nu-West and Huntsman Wells Cargo are ongoing. GM is further discussed in Section 5.5.8 and Section 5.6.9.

4.2 Additional Mine Facilities

Any structures (roads, ponds, OSAs, etc.) that are necessary for operations but not the actual pits are considered mine facilities. In addition to the mine facilities discussed in other portions of this MRP there are several other types of structures and/or facilities required to successfully implement the MRP at both H1 and NDR. Itafos proposes to construct or use the existing facilities listed below:

- Staging area
- Fuel storage area
- Dust suppression and water supply wells
- Train loading facility (tipple) and ore stockpiles
- Existing Dry Valley Shop Area (DV Shop Area).

Each of these structures and facilities is detailed in the following sections.

4.2.1 Staging Area

Staging areas will be constructed as places for miners to meet, receive operational instruction, and discuss safety items as needed. Facilities at the staging areas, such as mobile office trailers, may be fitted with shower(s) for emergency needs and have restrooms as required by applicable regulations. In addition, the staging facility will support emergency response/rescue equipment and vehicles.

The staging area will also have a “ready line” or a place to temporarily keep equipment when not in operation. The ready line may be used for minor maintenance. Power at the ready lines will be provided by either generators or overhead power line. Staging areas may have several secure cargo containers for storing items such as hydrocarbon spill cleanup materials, erosion water control materials and equipment, extra fire extinguishers, and other items as needed. Miners will drive to the DV Shop Area office parking area before being transported to staging areas.

Staging areas will be developed at multiple locations throughout the mine life. Staging areas will be both within the OZ and as indicated on the figures and maps. The staging areas will be constructed of low-SeW and in accordance with other design parameters within this document. Water management will be in accordance with the SWPPP and runoff will be managed as contact water.

4.2.1.1 Husky 1

Due to the steep, narrow topography and the sequence of pit phases, the H1 Lease mining area will require multiple temporary staging areas. Staging areas will be constructed at about every 10,000 to 12,000 feet of pit advance. The first staging area will be constructed approximately 2,000 feet south of the SMCM land bridge on the east side of the open pit adjacent to a portion of the haul road system that will connect the H1 pit to the train loading facility (tipple) and ore stockpiles in Dry Valley. The second staging area will be constructed on pit backfill adjacent to a widened haul road near the midpoint of the ultimate pit limits. The third staging area may be constructed toward the southern end of the ultimate pit limits.

4.2.1.2 North Dry Ridge

One staging area is required for the NDR Lease mining area. This staging area will be constructed on the west side of the north end of the NMM pit on a flat area of the existing and reclaimed West Ridge permanent overburden stockpile. The staging area will be constructed with a liner like the tipple area (see Figure 4-4). The 60 mils high-density polyethylene (HDPE) liner will be placed over a minimum of 6 inches of 3/8-inch minus material. At least 2 feet of limestone will be placed on top of the HDPE liner to provide a visual indicator showing the bottom of staging area, thereby protecting the liner during operations. An access road to the staging area will be constructed at a 50-foot road width to allow haul truck and supply transports to safely traverse this road. Full haul road widths are not required on this access road, as it will not be used for production haulage.

4.2.2 Fuel Storage Area and Containment Design

The existing DV Shop Area fuel storage area will be used as the fuel storage location. Fuel will be distributed from this site directly to equipment or by using fuel trucks that comply with relevant federal and state regulations. The total fuel storage capacity may be as much as 40,000 gallons. Fuel will be stored in multiple aboveground storage tanks to increase monitoring proficiency and for easier maintenance of containment structures. Barriers have been constructed under and around fuel tanks to meet applicable requirements for secondary containment of petroleum products. The DV Shop Area fuel storage area will be maintained according to relevant federal and state regulations and the H1NDR Spill Prevention, Control, and Countermeasure (SPCC).

4.2.3 Dust Suppression Wells with Water Fill Stands

Dust suppression water storage, water fill stand delivery systems, and water supply wells will be constructed as needed. Up to two proposed dust suppression water well locations for H1 and one dust suppression water well for NDR will be constructed. The dust suppression wells will be drilled within the boundaries of the H1 and NDR Leases, but not necessarily within the OZ. Water from these wells will be used to support mining operations. The primary use of these wells will be to supply water for spraying haul roads, access roads, and other areas requiring the suppression of dust from operations in accordance with relevant federal and state regulations. Water may be used for other, unforeseen, purposes but will not be classified as potable. It is estimated that Itafos will use between 80,000 and 200,000 gallons of water per day through the months of April to November. The quantity of water required is primarily a function of the haul road length required to transport ore or overburden for a given phase of mining and environmental conditions. Each well will most likely require the construction of water fill stand.

Contact water may also be used for dust suppression in areas such as within the pit, haul roads, ore stockpiles, or staging areas. Contact water used for dust suppression will only be used within zero discharge areas according to the site's SWPPP.

4.2.3.1 Husky 1

Up to two dust suppression and water supply wells will be needed to provide required water for H1. The wells are planned within the H1 OZ. The wells will require a dedicated electrical generator to provide power for the well pump.

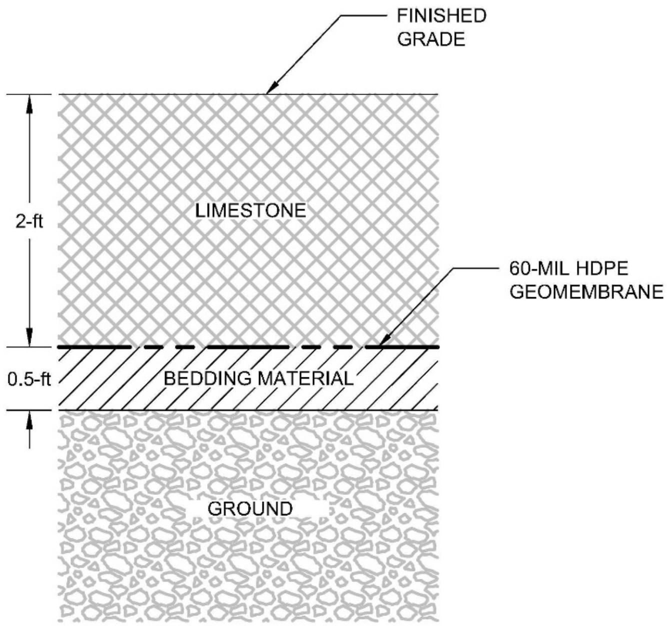
4.2.3.2 North Dry Ridge

A single dust suppression well will be constructed at the NDR mining area. The well is planned to be constructed within the NDR OZ.

4.2.4 Train Loading (Tipple)/Ore Stockpile Area

The train loading facility (tipple) and ore stockpiles will be constructed south of the first (lower) switchback of the MCM haul road. The proposed tipple area is east of the existing rail line and within the eastern portion of the DVM Pit D Lease. A haul road ramp will be constructed from the switchback to the tipple. The entire tipple area will be lined as shown on the figures and maps. The 60 mils HDPE liner will be placed over a minimum of 6 inches of 3/8-inch minus material. At least 2 feet of limestone will be placed on top of the HDPE liner to provide a visual indicator showing the bottom of stockpiled ore and the tipple pad, thereby protecting the liner during operations. Water management will be in accordance with the SWPPP and runoff will be managed as contact water. To accommodate railcar loading requirements, the public access road will be safely relocated around and away from the tipple area.

Figure 4-4: Typical Tipple Liner



4.2.5 Existing Dry Valley Shop and Offices

The existing Dry Valley shop/office facilities will be used as the main base for Project operations, to carry out major equipment repairs, to assemble and dismantle equipment, and for storage of most Project components. The Dry Valley offices will also be used for production engineering, geology, maintenance, and management staff. The Dry Valley yard area, with all its features, will be used as well including the fuel storage tanks, an equipment parking/hot start line, and a lay-down yard. Most vendors will arrive at the Dry Valley offices as opposed to the H1NDR production areas.