

Table 39. Stage Capacity Relationship Summary

Stage	Main Embankment Crest Elevation (ft)	Maximum Tailings Surface Elevation (ft)	Maximum Tailings Surface Area (acres)	Stage Storage Capacity (Mst)	Cumulative Storage Capacity (Mst)
1A	Varies (Max. 3583)	3581	42	0.40	0.40
1B	Varies (Max. 3595)	3593	44.7	0.58	0.98
2	Varies (Max. 3609)	3607	59.5	1.06	2.04
3	Varies (Max. 3622)	3620	83.0	1.60	3.64

3.6.4.4 Lining System

The TSF impoundment area and upstream slopes of each embankment will be continuously lined with both primary and secondary lining systems to provide continuous containment of process solution. The overall lining system will vary depending on the location within the facility. The proposed lined areas are presented on the Design Drawings in the *TSF Design Report* (Golder, 2021c; [Appendix C4](#)).

Golder performed an evaluation to compare an alternative lining system to the one prescribed in OAR 340-043-0130(3). The OAR guidelines for secondary containment are “an engineered, stable, soil/clay bottom liner (maximum coefficient of permeability of 10^{-7} cm/sec) have a minimum thickness of 36 inches.”

The evaluation compared the OAR guideline with both a standard geosynthetic clay liner (GCL) and an enhanced GCL. Both GCLs consist of a sodium bentonite layer between two geotextiles needle-punched together. The enhanced GCL contains an additional laminated, thin, flexible membrane barrier to offer an increased level of hydraulic performance (decreased hydraulic conductivity). To perform the comparison, the potential fluid travel time through each of the lining systems was evaluated for the following scenarios:

- Comparison of secondary containment alternatives alone (soil/clay liner versus GCL),
- Comparison of a 60-mil primary containment geomembrane liner with the secondary containment, and
- Comparison of an 80-mil primary containment geomembrane liner with the secondary containment.

Using the comparison of fluid travel times, the standard GCL did not meet the same performance standard as the soil/clay secondary layer (OAR requirement); however, the enhanced GCL exceeded the performance based on fluid travel time for all three scenarios. The enhanced GCL is proposed in place of the soil/clay secondary liner. The detailed evaluation is presented in the *TSF Design Report* (Golder, 2021c; [Appendix C4](#)).

Within the impoundment, the lining system will consist of (from bottom to top) a 6- to 12-in-thick native prepared subgrade, a 300-mil-thick enhanced GCL, an 80-mil HDPE geomembrane liner, an 18-in-thick drainage layer, and a 6-in-thick filter layer. Perforated piping will be located within the drainage layer to promote drainage of the tailings and to reduce hydraulic head on the lining system.

On the upstream embankment slopes, the lining system will be the same but without the overlying piping, drainage layer, and filter layer. Placement of a drainage layer above the geomembrane on the upstream

Newtonian flow; therefore, FLO-2D is considered an appropriate method for tailings flood routing and has gained wide acceptance for routing of tailings.

For this analysis, Golder evaluated the following critical scenario:

- Full Capacity Breach: The TSF is filled to the ultimate capacity at the end of Stage 3 with a maximum operating pool.
- Rainy Day Breach Event: The breach would occur concurrent with the addition of water from the Inflow design flood generated from the 500-year, 24-hour storm event (storm depth of 2.91 inches) during operation of the facility.
- Full-Depth Breach: To justify use of a full-depth breach from an engineering view, Golder assumed that the embankment breach would occur due to piping failure at a location along the downstream toe of the North embankment corresponding to the location of the maximum embankment height.

In this scenario, an estimated total volume of 1.07 M cubic yards would be released. This volume includes tailings, embankment material, and free water on the tailings surface. The findings from the inundation analysis include:

- The TSF flood flows would follow an existing ephemeral drainage running adjacent to Rock Canyon Road.
- The total tailings slurry deposition area inundated would be approximately 834 acres.
- Golder reviewed aerial imagery, and it is our understanding that there are no occupied structures within the tailings slurry inundation area.
- The modeled maximum tailings runout distance from the TSF is approximately 12 miles, beyond which flows would not pose a significant risk to human life.
- The peak flood travel time from the TSF to the maximum tailings runout distance (12 miles) would be approximately 48 hours.
- No habitations or lifelines would be impacted by the simulated event.
- Public access to the project site and areas south along Rock Canyon Road and Twin Springs would either be inaccessible, or access limited, until tailings solids could be removed. Alternative public access routes would remain operational.

The results of this analysis will be incorporated into a facility-specific Emergency Action Plan (EAP) prepared prior to construction of Stage 1a. The EAP will be prepared in accordance with FEMA's *Federal Guidelines for Dam Safety, Emergency Action Planning for dams*, FEMA 64 (FEMA 2013).

12.0 CLOSURE

The conceptual closure design of the TSF is intended to meet the OAR requirements. In accordance with the OAR 340-043-0140 (5) requirement, the tailings surface will be covered with a composite cover designed to prevent water and air infiltration. Upon completion of mining operations, active deposition into the TSF will cease. During this time, water collected in the TSF reclaim pond will be recirculated to the supernatant pool for active water management. Over time, the supernatant pool will evaporate and the underdrain flows reporting from the TSF will reduce as the tailings consolidate and drain. This is considered the active management period of closure.

Once the tailings surface no longer has a free water surface and the tailings continue to desiccate and densify, a closure cover can be constructed over the tailings surface and TSF embankments. The closure cover should be installed at a point in time where the majority of tailings consolidation has occurred and is not expected to negatively impact drainage of the closure cover.

The TSF closure cover is presented on the Design Drawings and will be constructed with the following (bottom to top):

- Operational layer of waste rock (if available) or other materials to provide vehicle access (as needed)
- 4 to 12 inches of Liner bedding (if required)
- 60 mil double sided textured linear low-density polyethylene (LLDPE) geomembrane liner
- 12 inches of non-acid generating granular drainage layer
- 12 ounce per square yard (oz/sy) non-woven geotextile
- 12 inches of growth medium, scarified and revegetated

The TSF Embankment closure cover is presented on the Design Drawings and will be constructed with 12 inches of growth medium that is scarified and revegetated.

Closure cover material will be sourced from the proposed Closure Cover Borrow Areas located northwest of the basalt quarry and southwest of the TSF (Golder 2021b)

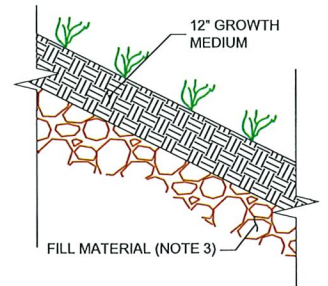
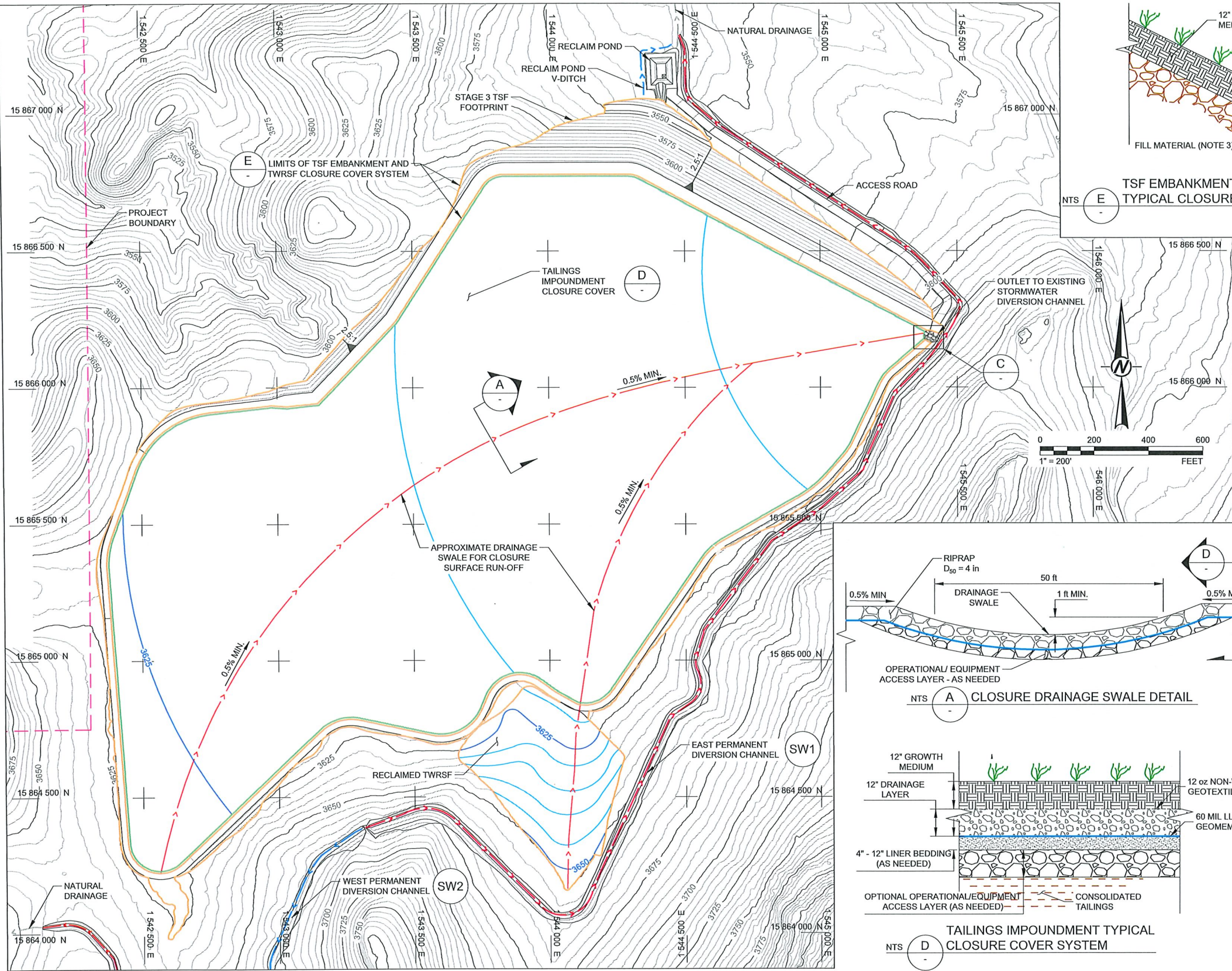
Upon cessation of mining operations, the remaining waste rock (if any) stockpiled on the TWRSF will be removed and placed as an operation layer above the tailings surface when it is safe to do so. The TWRSF lining system will either be removed or buried upon completion of mining operations.

During this time, water collected in the TSF reclaim pond will be recirculated to the supernatant pool for active water management. Over time, the supernatant pool will evaporate and the underdrain flows reporting from the TSF will reduce as the tailings consolidate and drain. This is considered the active management period of closure.

Once tailings underdrain flow rates reduce to levels considered appropriate for passive water management, the reclaim pond will be retrofitted to a geomembrane-lined evaporation pond. With installation of the closure cover and gravity drainage from the underdrain collection system, it is expected that underdrain flows from the TSF will cease.

Upon completion of closure cover construction, stormwater falling on the TSF and upgradient catchment areas below the permanent diversion channels, will be routed over the covered impoundment surface to a closure drop chute channel located at the eastern abutment of the North embankment. The closure drop chute and impoundment surface swale are designed to safely convey stormwater flows resulting from the 500-year, 24-hour storm. Conceptual closure of the TSF and TWRSF are presented on the Design Drawings.

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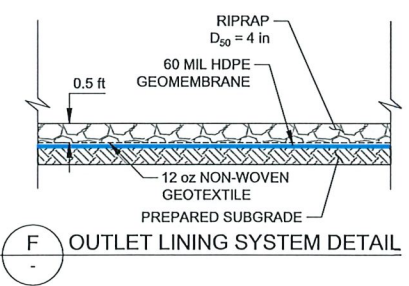
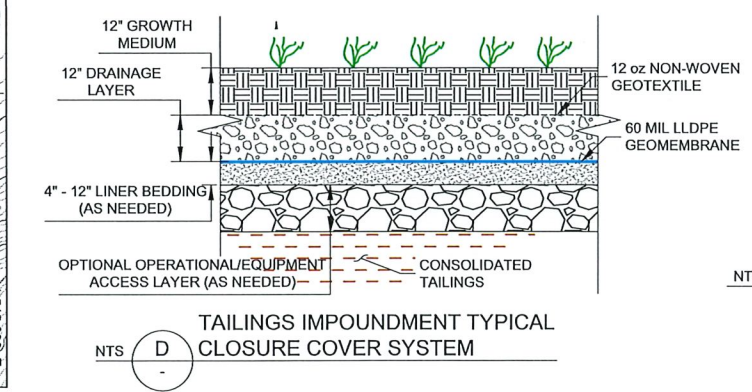
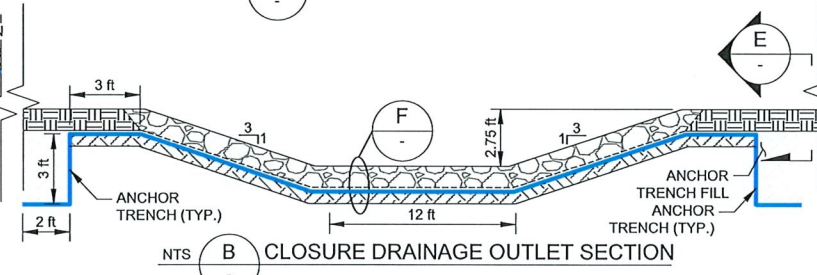
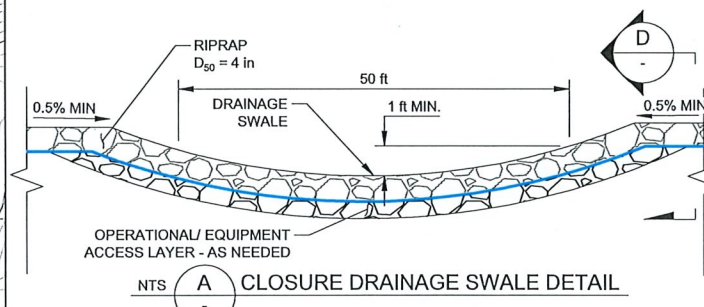
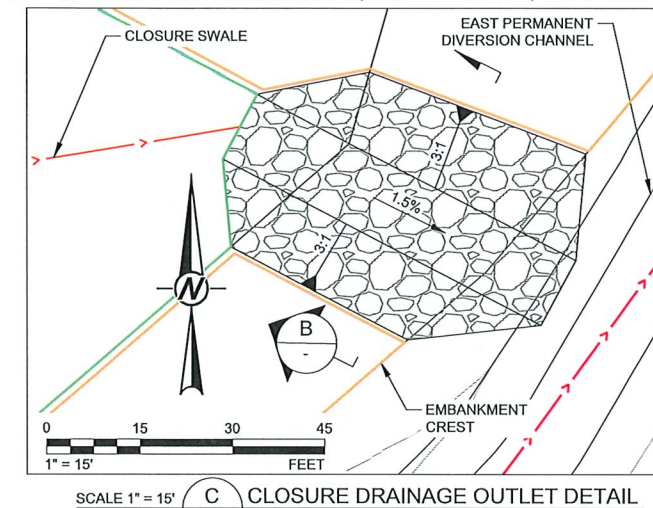


LEGEND

- EXISTING GROUND CONTOURS (5 FT CONTOURS) (NOTE 1)
- PROJECT BOUNDARY
- PERMANENT TRAPEZOIDAL STORMWATER DIVERSION CHANNEL
- PERMANENT V-DITCH STORMWATER DIVERSION CHANNEL
- CLOSURE DRAINAGE SWALE
- CONCEPTUAL CLOSURE GRADING (5 FT CONTOURS)
- NATURAL DRAINAGE
- LIMITS OF TAILINGS IMPOUNDMENT CLOSURE COVER
- LIMITS OF TSF EMBANKMENT AND TWRSF CLOSURE COVER

NOTES

- EXISTING GROUND AS SHOWN COMPRISED OF 2017 TOPOGRAPHY (REFER TO GENERAL NOTE 1) AND THE STAGE 3 TSF LAYOUT.
- STORMWATER LAYOUT PRESENTED ON DRAWINGS SW1 AND SW2.
- FILL MATERIAL MAY BE EMBANKMENT FILL, PERIMETER ROAD FILL, OR RECLAIMED TWRSF AREA.



REGISTERED PROFESSIONAL ENGINEER
92393PE
CHRISTOPHER J. MACMAHON
JULY 11, 2017
OREGON

ISSUED FOR CONSTRUCTION
EXPIRES: 12/31/2022

REV.	YYYY-MM-DD	DESCRIPTION	DESIGNED	PREPARED	REVIEWED	APPROVED
1	2021-10-29	REVISED AND RE-ISSUED FOR CONSTRUCTION	JRP	JRP	CJM	CJM
0	2019-11-06	ISSUED FOR CONSTRUCTION	MDB	JRP	CJM	RAB

CLIENT
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MEMBER OF WSP

PROJECT
GRASSY MOUNTAIN
TAILINGS AND TEMPORARY WASTE ROCK STORAGE FACILITIES
DETAILED DESIGN

TITLE
CONCEPTUAL CLOSURE PLAN

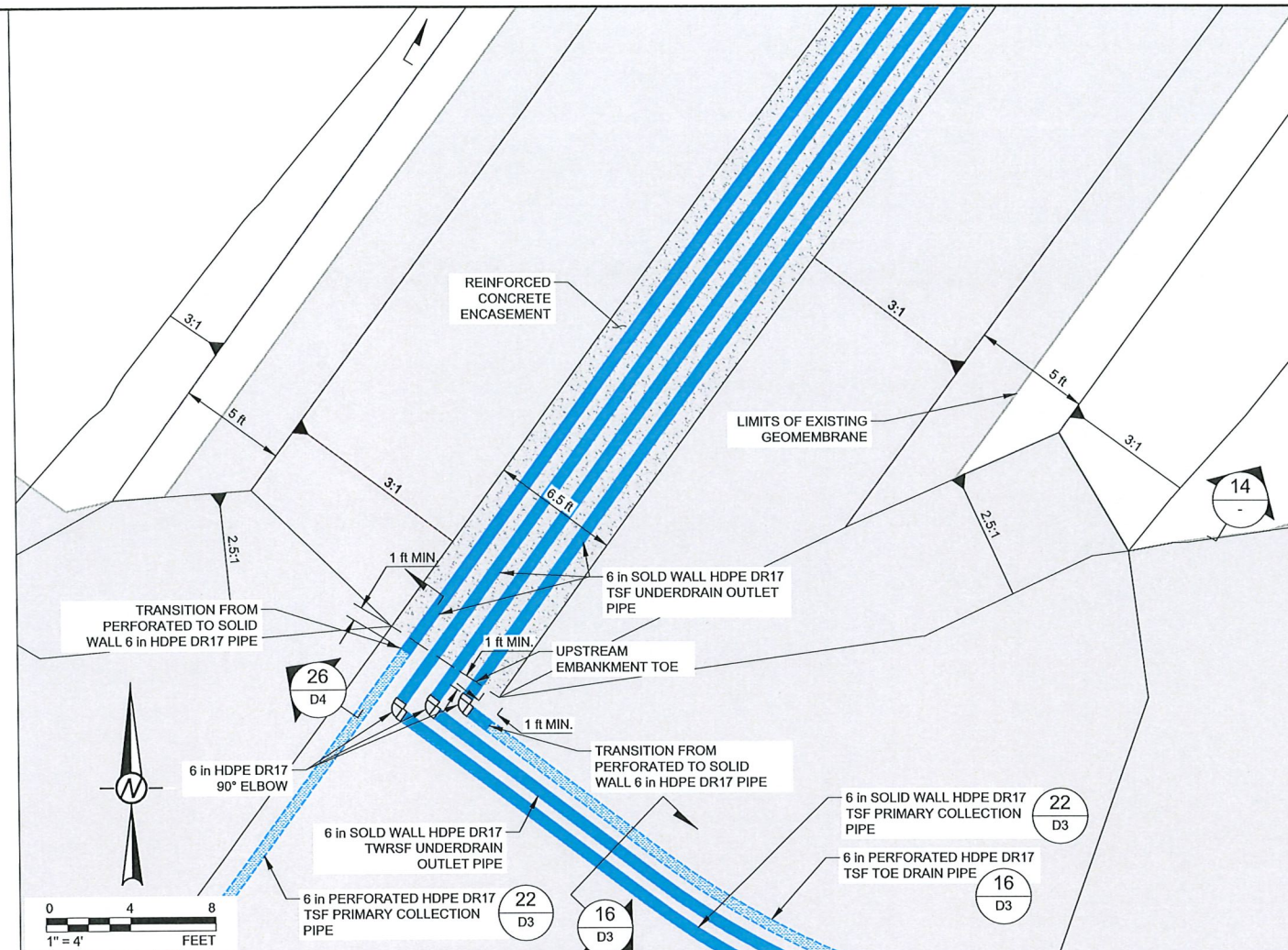
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1663241

REV.
1

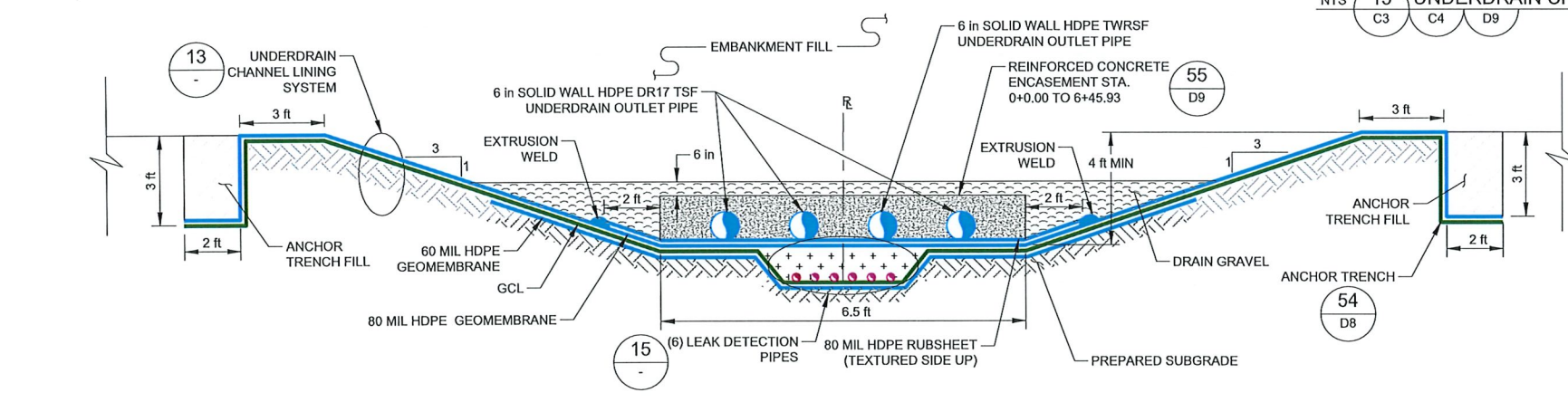
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DRAWING
C19

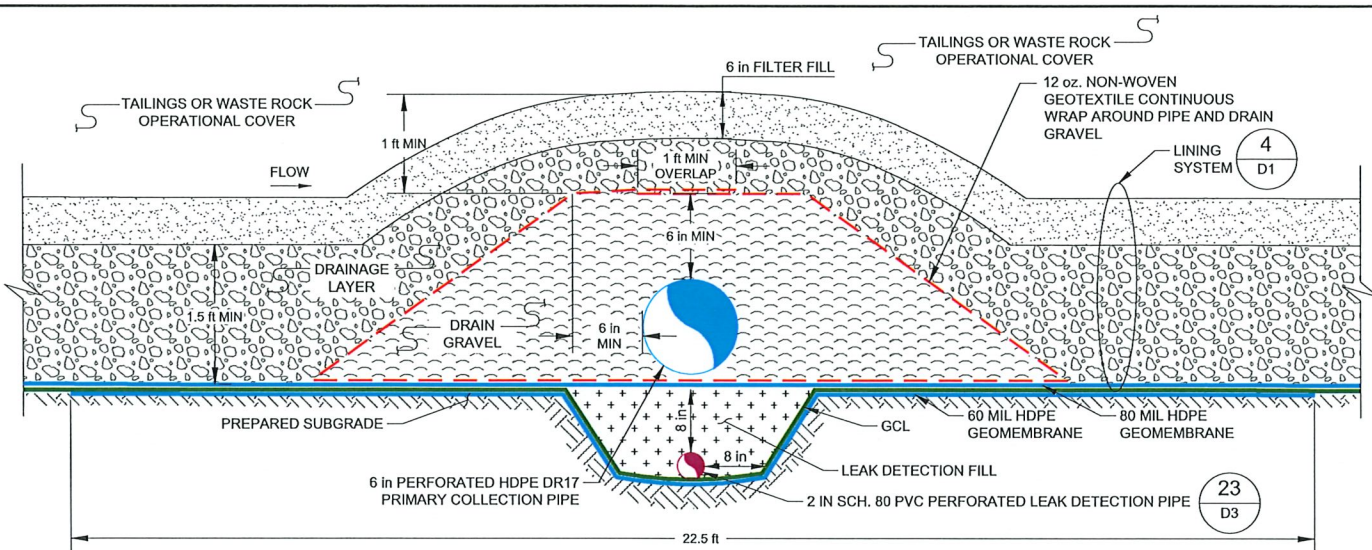
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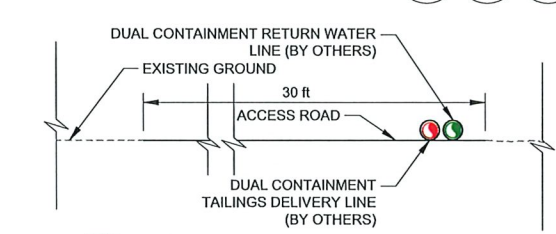
SCALE 1" = 4' **9 UNDERDRAIN CHANNEL INLET**
C17



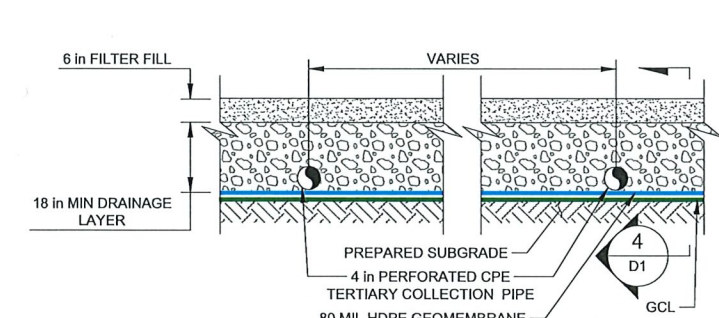
14 UNDERDRAIN CHANNEL BENEATH EMBANKMENT TYPICAL SECTION
C2 C3 C4 C17 C18 D6



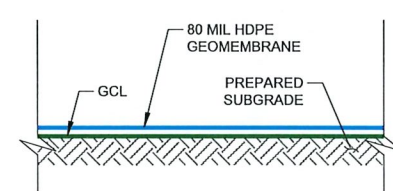
10 PRIMARY COLLECTION PIPE TYPICAL DETAIL
C17 C18 D3 D8



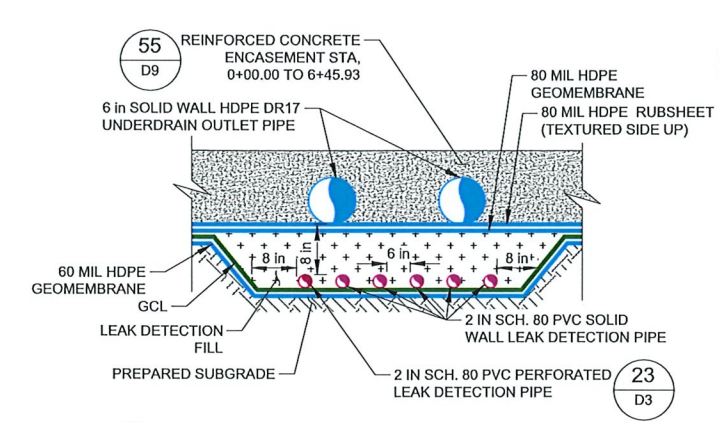
11 PERMANENT ACCESS ROAD SECTION
C5 C8 C10 C12



12 TSF BASIN AND TWRSF PIPING AND LINING SYSTEM DETAIL
C17 D1



13 UNDERDRAIN CHANNEL LINING SYSTEM
C3 C4 D9



15 LEAK DETECTION PIPES BENEATH CHANNEL DETAIL
C17 C18 D3 D4 D5 D6 D9

- LEGEND**
- 12 oz. NON-WOVEN GEOTEXTILE
 - HDPE GEOMEMBRANE
 - GCL
 - EXISTING GROUND
 - LIMITS OF EXISTING GEOMEMBRANE

ISSUED FOR CONSTRUCTION



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0	2019-11-06	ISSUED FOR CONSTRUCTION	MDB	JRP	CJM	RAB
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TITLE
**DETAILS (2 OF 9)
UNDERDRAIN COLLECTION SYSTEM**

PROJECT NO.
1663241

REV. 27 of 44
1

DRAWING
D2