DESIGN REPORT
POND 1 SOUTH EMBANKMENT
TOE EROSION PROTECTION
AMBROSIA LAKE MILL, NEW MEXICO

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POND 1 SOUTH EMBANKMENT TOE EROSION PROTECTION
AMBROSIA LAKE MILL, NEW MEXICO

Prepared for:

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INTRODUCTION

This design report was prepared by Maxim Technologies, Inc. (Maxim) for Rio Algom Mining Company, LLC. (Rio Algom) as part of their agreement for engineering services dated July 2001. Maxim has been retained to evaluate flood and long-term erosion conditions at the Ambrosia Lake Facility near Grants, New Mexico and to prepare designs for the long-term stability of tailings and evaporation ponds at this uranium mill tailings disposal site. This report provides the basis for the design required under Task 5. Task Five addresses erosion concerns at the toe of the south embankment of Pond 1, a reclaimed tailings pond, and consists of designing a channel/run-off apron for the south embankment of Pond 1. Figure 1 is a schematic representation of the area of concern in the current study.

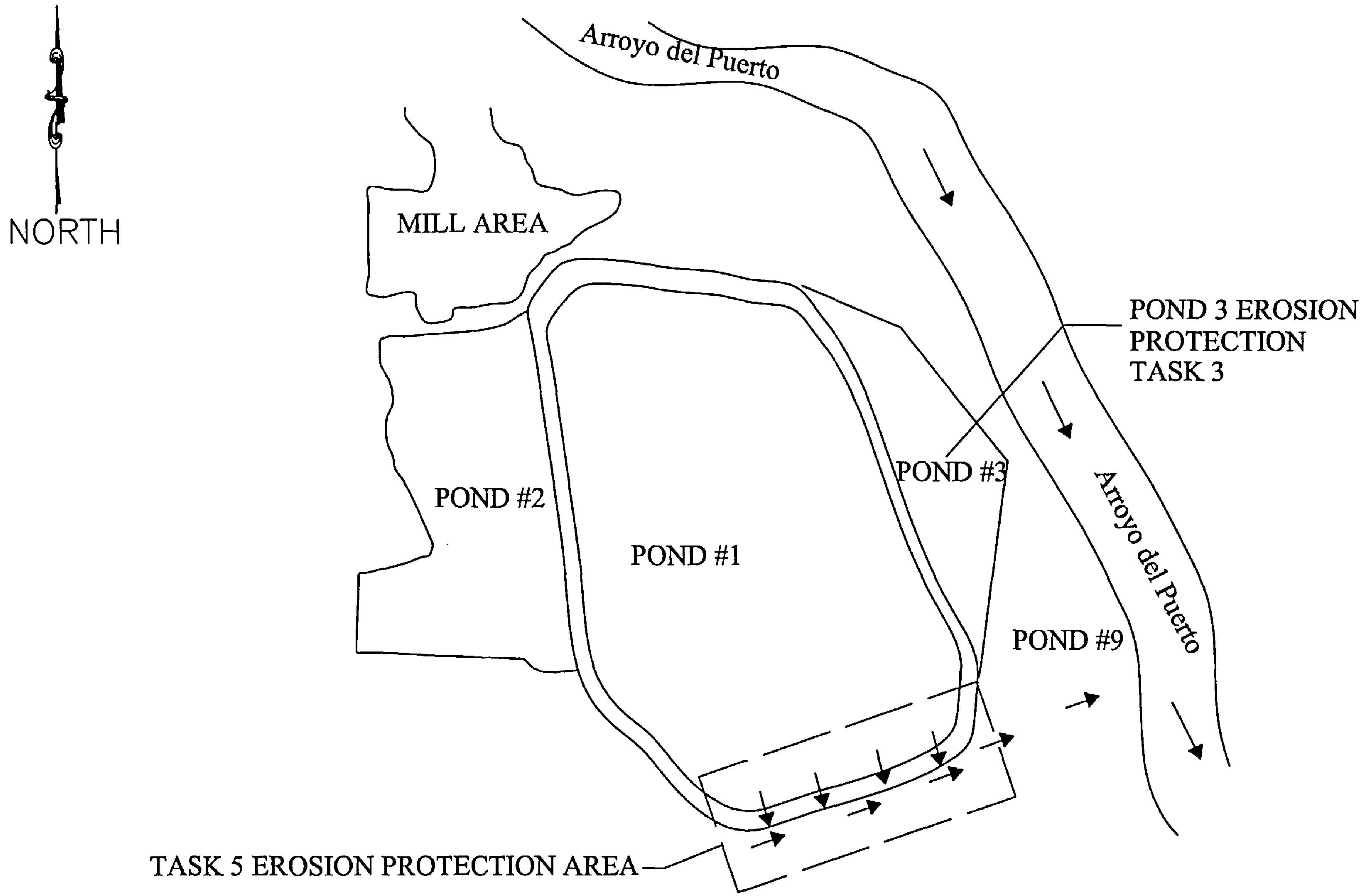
Pond 1 is a reclaimed tailings disposal site and was used for burial of byproducts produced at the mill. The embankment of Pond 1 is constructed with a radon barrier and overlying rock cover serving as erosion protection. The following report provides a design to prevent erosion of the embankment toe from run-off from the south embankment slope. For purposes of this design effort, it has been assumed that the erosion protection channel/apron shall only handle precipitation that falls on the south embankment slope or within the channel/apron limits. Local topographic information supplied by Rio Algom indicates precipitation that falls on the Pond top surface will run-off to the northwest and drain into the south diversion channel and then into the Arroyo del Puerto, which is hydrologically separate from the south embankment of Pond 1 and our proposed erosion protection system. The area south of the proposed erosion protection system drains to the south or east and away from the site on generally moderate slopes. Therefore, no other significant flows are anticipated to enter the channel/apron. The proposed erosion protection system for the south embankment toe of Pond 1 is a combination of an apron designed to withstand the hydraulic jump of the flow running of the steeper embankment slope onto the flat toe surface and a channel design that will withstand that longitudinal flow that is anticipated to run adjacent to the embankment toe. The greater design requirements for developing apron protection and channel protection were used to develop the design configurations that follow.

The analysis conducted for this design is consistent with Nuclear Regulatory Commission (NRC) guidance, particularly, *Design of Erosion Protection for Long-Term Stabilization* (Johnson 1999). This guidance, referred to as NUREG-1623 in this report, requires, in most cases, that erosion protection be designed for a 1,000-year life to minimize future maintenance issues. Because flood events with a 1,000 year recurrence interval are difficult to quantify, the guidance recommends use of the probable maximum precipitation event (PMP) for design purposes. PMPs can be derived for various parts of the United States using appropriate hydrometeorological reports. The report that addresses New Mexico east of the continental divide is *Hydrometeorological Report No. 55A, Probable Maximum Precipitation Estimates – United States between the Continental Divide and the 103rd Meridian* (Hansen *et al.* 1988). Appropriate PMPs are used to develop runoff hydrographs and determine the probable maximum flood (PMF) for an area of concern. The final step in the design process is to apply the PMF to the appropriate erosion control design method. Guidance for design of riprap erosion protection is found in Appendix D of NUREG-1623.

This design report is limited to those items affecting design of the south embankment of Pond 1 erosion protection, namely, the run-off issues mentioned previously. Methods of analysis are described for design issues including derivation of the PMP and calculation of the appropriate PMFs. The calculation of the riprap sizing is then described, and the report concludes with a discussion of other issues that affect the design.

1.0 PMP CALCULATION

Maxim verified the PMP calculation performed by others following the methods outlined in *Hydrometeorological Report No. 55A* (Hansen *et al.* 1988). The PMP rainfall depth calculated previously for the 1-hour local storm was 9.6 inches with no areal reduction. Maxim's calculation of the PMP depth



Legend:
→ Local Flow Direction

AMBROSIA LAKE MILL
RIO ALGOM MINING COMPANY, LLC.
GRANTS, NEW MEXICO

MAXIM TECHNOLOGIES INC

GENERAL OVERVIEW OF TASK	DRAWING BY: RLH 6/25/02
PROJECT No. 1690030-500 FILE NAME: 1690030T5Fig1.DWG	REVIEWED BY: WHB

FIGURE 1

arrived at a 9.5 inch value for the 1-hour, 1-square mile local storm, slightly less than the previously calculated value of 9.6 inches. Because the values are so similar, we used the slightly higher, previously determined values in our calculations. Calculation sheets are attached in Appendix A.

2.0 DESIGN BASIS

A run-off erosion protection channel/apron is needed along the south toe of the Pond 1 embankment to prevent scour from undercutting the tailings rock cover during extreme run-off events. Another erosion concern at the toe of the embankment is the potential for longitudinal flow along the toe due to moderate slopes adjacent to the toe. Therefore, the general approach for this analysis consisted of two tasks with the greater design requirements controlling the final design configurations.

1) Determining the apron requirements based on run-off analysis for the south embankment of Pond 1 in accordance with NUREG-1623, Appendix D, Section 6; and

2) Determining open channel requirements to control the run-off and longitudinal flow from the south embankment by an open channel in accordance with NUREG-1623, Appendix D, Sections 2 and 3.

Each of these analyses is described separately in this section of the report.

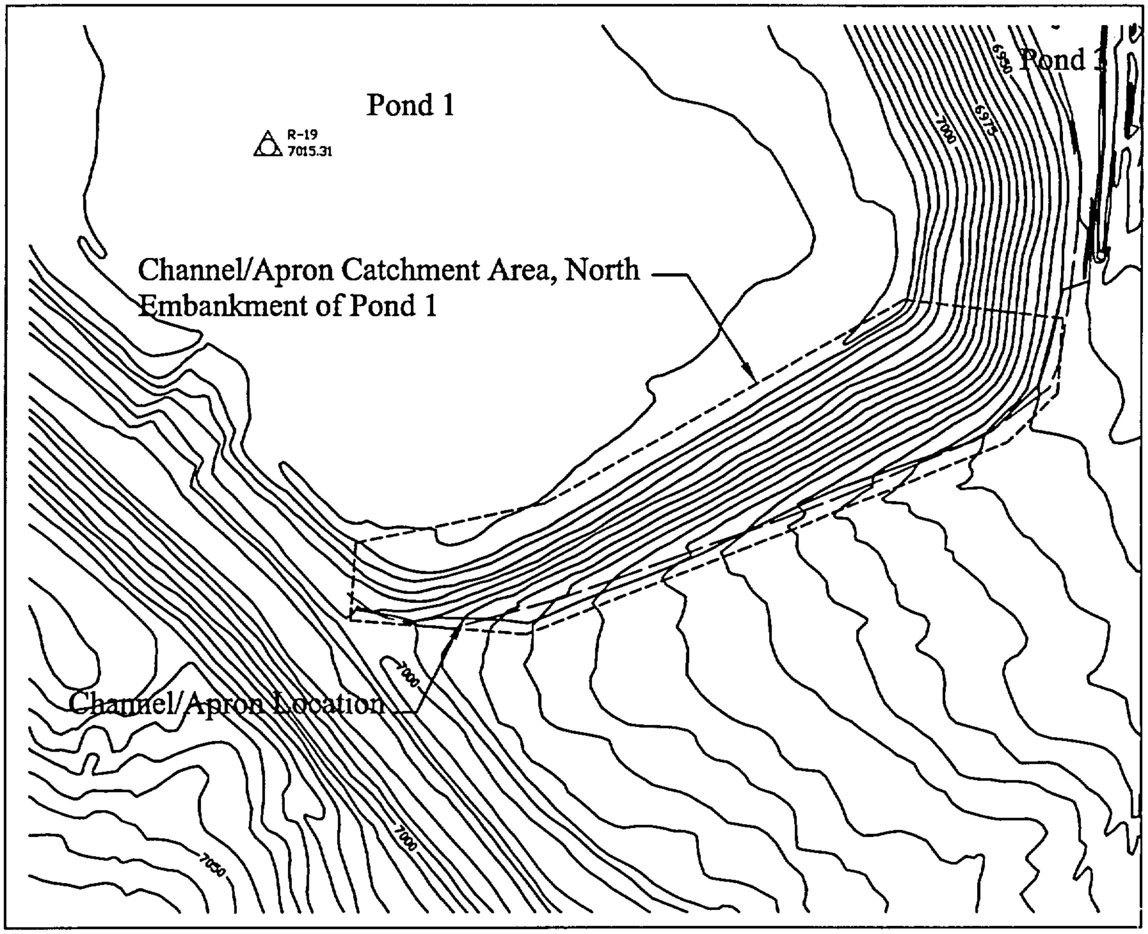
The development of this design is based on the 1 hr. local PMP depth for Pond 1 of 9.6 inches. The 19-acre catchment area includes essentially impervious covered tailings of the south embankment slope. In these calculations it is assumed that the entire catchment area is capped with a rock cover and is impervious. This catchment drains to the south, down the 5H:1V embankment slopes and exits in an existing internal apron that is constructed along the entire Pond 1 embankment toe. Visual observations during site visits have indicated that minor erosion has occurred outside the internal apron on the adjacent unprotected natural soils; therefore, redesign and replacement of the existing apron is necessary. Replacement of the existing apron will be required in order to install the new channel/apron. The proposed design is an external channel/apron that will replace the current internal apron. The catchment area is shown on Figure 2.

2.1 EROSION PROTECTION APRON FLOW

For the 19-acre catchment, a time of concentration was calculated using the longest embankment slope achievable to evaluate rock sizes in the erosion protection apron design. The slope length used for this calculation is 452 ft in length, producing a time of concentrations of 1.65 minutes. This time of concentration is below the smallest incremental rain duration provided by Nelson et all (1986) for developing a PMF depth. Therefore the shortest increment rainfall duration of 2.5 minutes was used in developing the 2.5 minute PMP depth. The 2.5 minute PMP depth for a local storm of 9.6 inches is 2.64 inches. Using a runoff coefficient of 1.0, the Rational Method gives a unit peak flow of 0.63 cfs/ft for this catchment with the slope length of 452 ft. Using a maximum embankment slope of 20 percent and a flow concentration factor of 2.5, the method of Abt *et al.* (1998) predicts a rock d_{50} of 6.7 inches for the toe apron at the base of the slope. Calculations are provided in Appendix B.

2.2 EROSION PROTECTION CHANNEL/APRON FLOW

Due to the moderate longitudinal slopes at the toe of the south embankment of Pond 1, a second design approach was evaluated for providing erosion protection at the toe of the south embankment of Pond 1. The moderate slopes will induce longitudinal flows along the embankment toe, which could cause instability of the embankment by erosion. This approach places an open channel/apron at the base of the slope that will catch the precipitation that falls on the embankment slope and runs off. The Figure 2



NOTE: The channel/apron will capture the run-off from the south embankment of Pond 1 and route it to the east where it will be discharged into the Arroyo del Puerto.

NORTH
1 in. = 500 ft

AMBROSIA LAKE MILL RIO ALGOM MINING COMPANY, LLC GRANTS, NEW MEXICO TASK 5 EROSION PROTECTION		MAXIM TECHNOLOGIES INC
CATCHMENT AREA	DRAWING BY: RLH 6/24/01	
PROJECT No. 1690030-500 FILE NAME: 1690030T5Fig2.DWG	REVIEWED BY: WHB	FIGURE 2

open channel/apron approach takes into consideration NUREG-1623 erosion control apron parameters as well as NUREG-1623 channel parameters and the Army Corp of Engineers, *Hydraulic Design of Flood Control Channels,* design methods (ASCE 1995). According to previous phone discussions with Mr. Ted Johnson of the Nuclear Regulatory Commission (NRC), the parameters provided within the NUREG-1623 shall be adequate for design of open channels, using Sections 2 and 3 of Appendix D, the Abt and Johnson Method. The open channel terminates at a discharge apron in the Arroyo del Puerto Basin.

The channel/apron separates from the embankment near channel stationing 21+75, at which point the channel/apron becomes a discharge channel (See Sheet 1 for general layout, Appendix D). The southeast portion of the embankment toe that requires erosion protection will be protected by a toe apron system. The southeast toe of the embankment is generally flat and longitudinal flows are not anticipated thus no channel has been incorporated in this portion of the apron design. See Section 2.5 for development of the toe design for the southeast apron.

The flow for the channel/apron originates on a 19 acre area. A time of concentration was developed using the maximum flow length on three sections of the channel/apron. The channel/apron was broken into three sections to maintain a designated rock size by altering each of the channel/apron configurations. The time of concentration for each section included the length of run-off from the embankment slope at station 0+00 of 200 ft. The starting elevation of 7,020 ft with an ending elevation of; 6,959 ft for the first section, 6,941 ft for the second section, and 6,910 ft for the third section and discharge apron was used to develop the time of concentrations for these sections. The flow lengths of these three sections are 1,600 ft, 2,350 ft, and 3,500 ft, respectively. With these parameters, the time of concentration was calculated for each section, 8.1 minutes, 11.4 minutes, and 15.9 minutes, respectively. From Nelson et all (1986), an 8.2 minute, 11.4 minute, and 15.9 minute PMP depth for a local storm of 9.6 inches was determined to be 5.3 inches, 6.1 inches, and 7.3 inches, respectively. The Rational Method gives a peak flow of 328 cfs, 443 cfs, and 543 cfs, respectively, at the end of each section. Calculations are found in Appendix C.

2.3 CHANNEL/APRON CONFIGURATION

The channel/apron configuration was developed using the results of the flow calculations noted above in conjunction with NUREG-1623 Sections 2 and 3 and Flow Pro 2.0, a hydraulic design software for steady-state open channel flow. The software was used to develop a flow depth in the proposed channel/apron sections. All other channel/apron dimensions were developed using recommendations from the NUREG-1623 and relations established by Abt *et al.* (1998). The more protective of the requirements for developing a channel configuration between channel design and apron design was chosen for the channel/apron development. Manning's roughness value was developed using equation 3-2 of Section 3, Army Corps of Engineers, (ASCE, 1995). The roughness value was then entered into the open channel modeling software with an estimated channel width greater than or equal to the D_{50} of the calculated apron rock size times 15 (the requirement for apron width from Section 6 of the NUREG), and the calculated flows noted above for the channel/apron. The sideslope rock size was sized 1.2 times larger according to the methods of ASCE (1995) with the expectation that D_{50} not exceed 7.5 inches. If the rock size exceeded D_{50} = 7.5 inches, a wider channel width was selected to reduce the rock size.

The channel slope of 2.3 % is an average slope of the existing grades for the length of the channel/apron and is based on the survey information provided by Rio Algom. With the times of concentration, the incremental storm depths, the peak flows, and the bottom widths determined using the Flow Pro software, a rock size of D_{50} = 7.5 inches was not exceeded for this erosion protection design using a channel bottom width of 14 ft from STA 0+00 to STA 14+00, a bottom width of 18 ft from STA 14+00 to STA 21+75, and a bottom width of 22 ft from STA 21+75 to the channel/apron end, STA 33+00. A minimum channel depth of 3.7 feet will be necessary to control the longitudinal flows as well as protect the toe from erosion through the channel/apron.

The channel bottom widths for longitudinal flow along the channel/apron is also adequate using the design criteria found in NUREG-1623, Section 6 for apron design. The rock size of D50 = 6.7 inches determined in Section 2.1 would require an apron width of 8.4 feet, which is exceeded by the longitudinal flow requirements for bottom width in each section.

Existing longitudinal grades at the embankment toe from STA 0+00 to STA 5+00 range from 2.3% to 5.5% for short distances as determined from the survey information provided by Rio Algom. A rock size verification for the channel/apron grades between STA 0+00 and STA 5+00 was performed using the steeper grades. The results indicated that a rock size of D_{50} = 5.3 inches would be required to prevent erosion during a storm event, therefore, the selected rock size from STA 0+00 to STA 14+00 of D_{50} = 7.5 inches is adequate. The verification calculations are shown in Appendix C.

The calculations for this section of the report are shown in Appendix C. The open channel modeling software outputs of the depth of flow in the channel with the above noted input parameters are also included within the calculation section. The channel/apron configuration and location are shown on the design drawings in Appendix D.

2.4 DISCHARGE APRON CONFIGURATION

Run-off from the south embankment of Pond 1 collects in a channel/apron along the toe and is then directed easterly along the toe to approximately station 21+75 where it is routed away from the embankment toe to a discharge apron. The intent of the discharge apron is to spread water on the native ground downstream of the pond. A maximum velocity of 4 ft/sec was chosen as the design criteria for allowing water to disperse on the native material. A toe is constructed at the edge of the discharge apron to prevent scour beneath the apron. The scour method of Abt *et al* (1996) was used to determine the depth of scour for the PMP. The downstream toe as well as the training wall and wingwall toes are designed to this scour depth. Calculations are found in Appendix C.

Wingwalls extend for an additional 25 feet beyond the apron to protect the corners of the apron. The wingwalls are constructed with a rock toe extended to the scour depth with 2H:1V side slopes. Before covering the rock toes of the apron and wing walls with compacted native materials, the contractor should work filter rock into the upper portion of the rock to prevent the loss of native materials in voids.

2.5 EROSION PROTECTION APRON – SOUTHEAST PORTION OF POND 1

For the southeast portion of Pond 1 embankment, more specifically, west of Pond 3 and north of the southeast corner of Pond 1, we used an erosion protection toe apron design, which prevents scour at the base of the embankment slope. The topographic information provided by Rio Algom indicates that longitudinal flows are not expected in this general area; therefore, a channel/apron type erosion protection system is not necessary. The design grade of the embankment is 20%, according to Rio Algom. This value was verified to be between 17% and 20% by the topographic information supplied by Rio Algom. For this portion of the Pond 1 embankment erosion protection plan, a time of concentration and unit peak flow discussed in Section 2.1 were used in conjunction with a 20% embankment slope, a run-off coefficient of 1.0 (rock covered surface with no infiltration), and the method of Abt *et al.* (1998) to predict a rock D_{50}=6.7 inches for erosion protection at the interface of the embankment toe and the native soil in this area.

In an effort to reduce the number of rock gradations used to complete several design tasks for erosion control at the mill site, the apron configurations were adjusted appropriately to fit a common rock size of other design tasks. A rock of D_{50} = 7.5 inches was previously selected for use in an erosion control design at the mill site, the same rock size has been selected for use in this erosion control apron.

3.0 OTHER DESIGN/CONSTRUCTION CONSIDERATIONS

As part of this erosion protection design, the existing erosion control apron must be removed and the subgrade properly re-graded such that run-off from the embankment flows into the proposed channel/apron and toe apron. It is recommended that the entire existing apron be removed as part of the proposed construction and replaced with this proposed channel/apron. Because the channel/apron should fit the topography at the toe of the embankment, some variation from the design grade will be required during construction. Any deviations outside the range 1.5 % to 3.5 % should be evaluated hydraulically to ensure adequate performance of the channel/apron.

The suitability of rock to be used as erosion protection at the Ambrosia Lake Mill was assessed by Rio Algom and from the laboratory test results of the physical characteristics of the rock source; an oversizing of the rock was required. Oversizing for the rock was based on a placement location for critical areas as outlined in Section 7.2.2 of NUREG-1623. The NUREG scoring criteria used on four laboratory samples submitted by Rio Algom resulted in an average rock grading of 76%. In accordance with NUREG and Critical Areas the rock in this design report was oversized by 4%. The design calculations were based on the expectations to not exceed a 7.5 inch nominal rock size. With the oversizing factor of 4%, a 7.8 inch nominal rock size was incorporated into the channel/apron, discharge apron, and toe apron design configurations.

4.0 REFERENCES

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United States Army Corps of Engineers, 1995, *Hydraulic Design of Flood Control Channels.* Change 1. Hydrologic Engineering Center, Davis, California

APPENDIX A

PMP/Local Storm Calculation

MAXIM TECHNOLOGIES INC BY B. Bucher DATE 7/11/01

JOB TITLE Quivira - Engineering JOB NUMBER 1690030

SUBJECT PMP Calculation - Local Storm SHEET

Reference: Hydrometeorological Report No. 55A
U.S. Dept. of Commerce, NOAA, June 1988

Calculate local storm PMP for mine site following method in Section 14.3.

1. 1-hr 1mi² PMP at 5000 ft el. from Plate VIc
10.5 in.

2. Elevation adjustment - use 7,000 ft site elevation
Maximum 12-hr persisting 1000 MB Dew Point = 76.6°F from Figure 4.11
From Figure 14.3 - Elevation adjustment = 0.90

3. 0.90 × 10.5 in = 9.5 in 1 mi² - 1 hr.

4. From Table 12.4, 6 hr storm is 1.35 × 1 hr. storm
9.5 × 1.35 = 12.8 in

5. Areal reduction factors will depend on basin.

For Arroyo del Puerto Basin

1. 1 hr - 1 mi² PMP at 5000' El = 10.4" from Plate VIc

2. Assume average basin el of 7500'; max 12 hr persistent 1000 MB dew point = 76.6°F
Elevation adjustment = 0.86

3. 0.86 × 10.4 = 8.9" 1 hr - 1 mi² PMP

5. For 1 hr storm areal reduction factor is .58
Basin Area = 57 mi²
0.58 × 8.9 = 5.2"

APPENDIX B

CALCULATIONS FOR POND 1
EROSION PROTECTION APRON
SOUTH EAST CORNER

Apron Calculations:

Using Method of NUREG CR-1623 Appendix D. Section 6 - Rip Rap Sizing

1.) Slope Length:

Longest 452.3 ft (Using Aerial Survey)

2.) Pond 1 Embankment Slope:

Embankment Design Slope = 20%

3.) Time of Concentration:

$$t_c = (11.9\ L^3/H)^{0.385}$$

$$= \left(11.9 \times \frac{452}{5280}^3 / (7025 - 6940)\right)^{0.385}$$

$$t_c = 0.027\ hr = 1.65\ min.$$

4.) *Using 2.5 min rainfall increment from Nelson et al. (1986)

* (Shortest Increment Available)

2.5 min PMP = 0.275 x 9.6" = 2.64"

(Using 9.6" PMP For Local Storm)

5.) Using Rational Method For Unit Flow/Width

L = 452 Area = 452' x 1 ft = 452 ft^2 = 0.010 acres

$$\text{intensity}, i = 60 \times \frac{2.64}{2.5} = 63\ in/hr.$$

(continued)

MAXIM TECHNOLOGIES INC

JOB NO. 1690030-500 **JOB TITLE** Rio Algom **DATE** 5/1/02 **BY** RLH

SUBJECT Apron Calculations **CHECKED** ________ **SHEET** 2 **OF** 2

6.) Flow, q_u: (Unit Flow)

$q_u = Cia = 1.0 \times 63 \times 0.010$

$q_u = 0.63$ cfs/ft

$C = 1.0$ (Rock Covered Embankment Slope)

7.) Using Equation D-18 From NUREG 1623 Appendix D - Rock Sizing:

Concentration Factor, $C_f = 2.5$

$D_{50} = 10.46 \times S^{0.43} (C_f \times q_u)^{0.56}$

$D_{50} = 10.46 \times (0.20)^{0.43} (2.5 \times 0.63)^{0.56}$

$D_{50} = 6.7$ inches Minimum

8.) Apron Configurations:

Using NUREG 1623 - Apron Configurations

1.) Minimum Depth of Rock Apron @ 6.7"

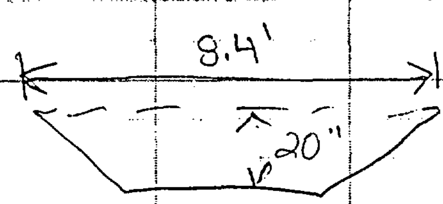
Depth = $3 \times D_{50}$

D = 20.1 inches

2.) Minimum Width

Width = $D_{50} \times 15$

W = 100.5 inches = **8.4' = W**



Note: For Consistency w/ Project Results D_{50} = 7.8" will be Used (oversized)

APPENDIX C

CALCULATIONS FOR POND 1
EROSION PROTECTION CHANNEL/APRON AND DISCHARGE APRON

Channel Sizing w/ Rock Sizing

I. By Section

Method: Calculate Flows For 3 Sections Using NUREG 1623 Guidance Appendix D

1.) Sections

Sec 1 STA 0+00 to STA 14+00

Sec 2 STA 14+00 to STA 21+50

Sec 3 STA 21+50 to STA 33+00 (End)

2.) Channel Sizing and Rock Sizing Sec 1:

Parameters

Channel Length = 1400 ft + 200 ft for t_c

* 200 ft is embankment slope length start

Area of Drainage = 8.4 acres

Change in elevation:
7020 ft to 6959 = 61 ft

Slope (Average Slope For Rock Size) = 2.3%

2.1) Time of Concentration: t_c

$$t_c = \left[11.9 \cdot \left(\left(\frac{1600}{5280} \right)^3 \middle/ 61\,ft \right) \right]^{0.385}$$

$t_c = 0.134$ hrs $=$ 8.1 min

2.2) Intensity: i

From Table 2.1 (Nelson, 1986)

8.1 min PMP = 55% (9.6") = 5.3"

$i = 60 \times 5.3/8.1 =$ 39.1 in/hr

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JOB NO. 1690030-500 JOB TITLE Rio Algom DATE 2/21/03 BY RLH

SUBJECT Channel Section Size / Rock Sizing CHECKED ______ SHEET 2 OF 5

2.3) Flow, Q:

$Q = CiA = 1.0 \times 39.1\ \text{in/hr} \times 8.4\ \text{Acres}$

$\underline{Q = 328\ \text{cfs}}$

2.4) Channel Configurations:

- 14 ft Wide Bottom
- 2H:1V Slopes
- Average Slope = 2.3%
- PMP = 9.6" 1hr - mi²
- Flow = 328 cfs

2.5) Rock Sizing:

$D_{50} = 5.23 \times q_u^{0.56} \times 0.023^{0.43}$

$D_{50} = 5.23 \times (328/14)^{0.56} \times (0.023)^{0.43}$

$D_{50} = 6.0$ inches Bottom Rock

Per ACE For Channel Side Slopes

$D_{50} = 6.0" \times 1.2 = 7.2"$

$\underline{D_{50} = 7.2"}$

2.6) Oversizing:

Due to Selected Rock Source Selected Rock Requires A 1.04 (4%) oversizing

$D_{50} = 7.2" \times 1.04 = 7.5"$

$D_{50} = 7.5"$ Minimum

$\underline{D_{50} = 7.8"}$ From Other Tasks

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JOB NO. 1690030-500 JOB TITLE Rio Algom DATE 2/21/03 BY RLH

SUBJECT Channel Section Size/Rock Sizing CHECKED ________ SHEET 3 OF 5

3) Channel Sizing & Rock Sizing Section 2:

Parameters

Channel Length = 2150 + 200 for t_c

Area of Drainage = 13.7 acres

Change In Elevation:

7020 to 6941 = 79 ft

Slope (Average Slope For Rock Size) = 2.3%

3.1) Time of Concentration, t_c:

$$t_c = \left[11.9 \times \frac{(2350/5280)^3}{79} \right]^{0.385}$$

t_c = 0.189 hrs = 11.4 min

3.2) Intensity, i:

From Table 2.1 (Nelson, 1986)

11.4 min PMP = 64% (9.6") = 6.1"

$i = 60 \times 7.3 / 11.4$ = 32.3 in/hr

3.3) Flow, Q:

$Q = 1.0 \times 38.3$ in/hr $\times$ 13.7 acres

Q = 443 cfs

3.4) Channel Configuration:

- 22 ft Wide Bottom
- 2H:1V Side Slopes
- Average Slope = 2.3%
- PMP = 9.6"/1 hr-mi²
- Flow = 443 cfs

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SUBJECT Channel Section Size/Rock Sizing CHECKED ________ SHEET 4 OF 5

3.5) Rock Sizing:

$D_{50} = 5.23\lambda(443/22)^{0.56} \times (0.023)^{0.43}$

$D_{50} = 5.6''$ Bottom

$D_{50} = 5.6'' \times 1.2 = 6.7''$ Side Slope

$D_{50} = 6.7''$

3.6) Oversizing:

Oversize Factor = 1.04, (4%)

$D_{50} = 6.7 \times 1.04$

$D_{50} = 7.0''$

$D_{50} = 7.8''$ From Other Tasks

4) Channel Size and Rock Sizing Section 3:

Parameters:

Channel Length = 3300 + 200 for t_c

Area of Drainage 19.8 acres

Change In Elevation:

7020 − 6910 = 110 Ft

Slope (Average Slope For Rock Size) = 2.7%

4.1) Time of Concentration

$t_c = \left[11.9\left(\frac{(3500/5280)^3}{110}\right)\right]^{0.385}$

$t_c = 0.264$ hr = 15.9 min

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SUBJECT Channel Section Size/Rock Sizing CHECKED ______ SHEET 5 OF 5

4.2) Intensity, i:

From Table 2.1 (Nelson, 1986)

15.9 min PMP = 75.6% (9.6") = 7.3"

$i = 60 \times 7.3 / 15.9 = \underline{27.4 \text{ in/hr}}$

4.3) Flow, Q:

$Q = 1.0 \times 27.4 \text{ in/hr} \times 19.8 \text{ acres}$

$\underline{Q = 543 \text{ cfs}}$

4.4) Channel Configurations:

- 22 ft wide Bottom
- 2H:1V slope of sides
- Average slope = 2.3 %
- PMP = 9.6" 1hr-mid
- Flow = 543 cfs

4.5) Rock Sizing:

$D_{50} = 5.23 \times (543/22)^{0.56} \times (0.023)^{0.43}$

$D_{50} = 6.2''$ Bottom

$D_{50} = 6.2 \times 1.2$ Side Slopes

$D_{50} = 7.4$ inches Side Slopes

4.6) Oversizing:

Oversizing Factor = 1.04, (4%)

$D_{50} = 7.4 \times 1.04$

$D_{50} = 7.7''$

$\underline{D_{50} = 7.8''}$ From other Tasks

Task 5 Channel Design - Channel - Inputs to get channel Depth

DISCHARGE CHANNEL

1. MANNING OUTPUT SECTION 1

OPEN CHANNEL DESIGN - STRICKLER'S EQUATION

ASSUMPTIONS & EQUATIONS Where K=Ave Flume Data (ACE 1994)

Mannings Value, n ~ K(D90)^0.16667

D90 of D50 = 7.8 inch Rock Particle Distribution = 12" (See Design Report For Gradation)

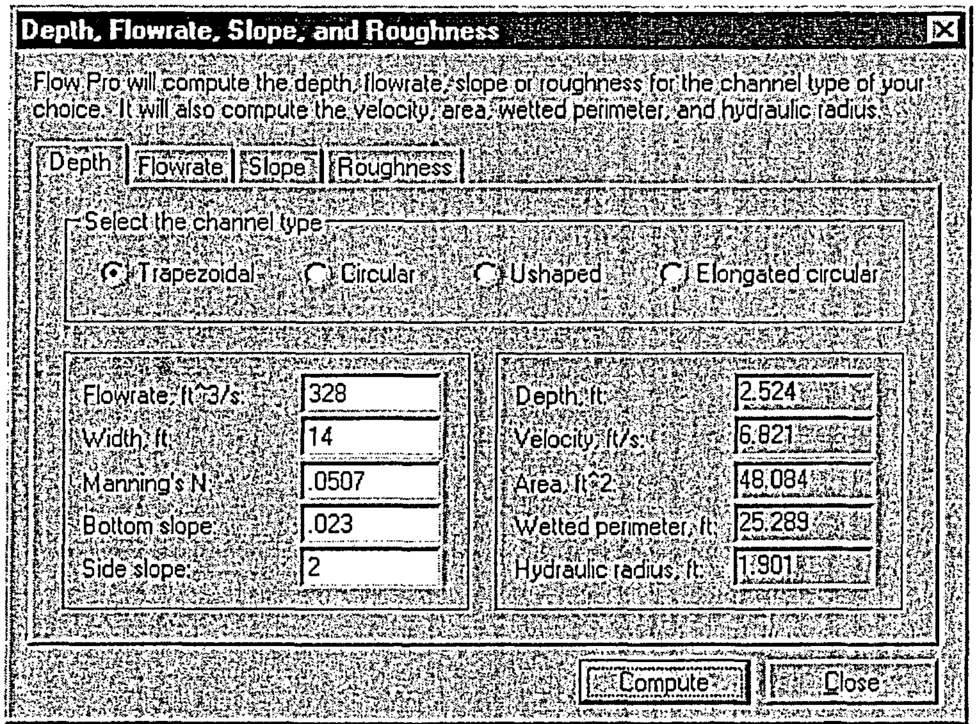
Note: Army Corp. of Engineers - Hydraulic Design of Flood Control Channels (1991)

CALCULATION: Using Army Corp. Of Engineers (ACE) Method (ACE, 1991)

Inputs	Value	Units
D50'	7.8	inches

Output	Value	Units
n	0.0507	

2. CHANNEL DEPTH OUTPUT



Task 5 Channel Design - Channel - Inputs to get channel Depth

DISCHARGE CHANNEL

1. MANNING OUTPUT SECTION 2

OPEN CHANNEL DESIGN - STRICKLER'S EQUATION

ASSUMPTIONS & EQUATIONS Where K=Ave Flume Data (ACE 1994)

Mannings Value, n ~ K(D90)^0.16667

D90 of D50 = 7.8 inch Rock Particle Distribution = 12" (See Design Report For Gradation)

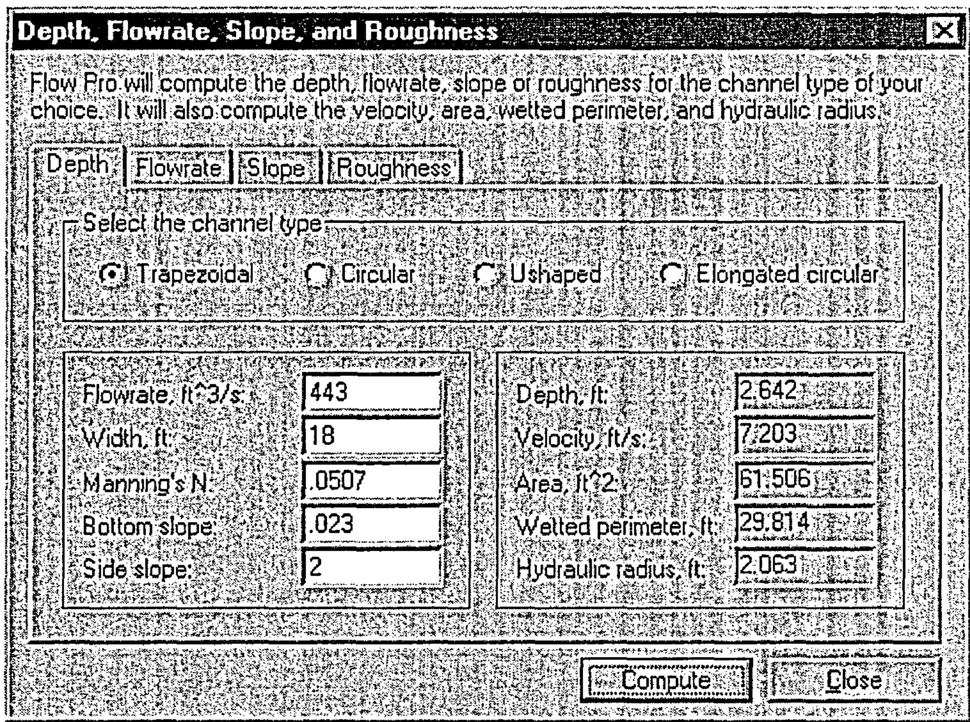
Note: Army Corp. of Engineers - Hydraulic Design of Flood Control Channels (1991)

CALCULATION: Using Army Corp. Of Engineers (ACE) Method (ACE, 1991)

Inputs	Value	Units
D50'	7.8	inches

Output	Value	Units
n	0.0507	

2. CHANNEL DEPTH OUTPUT



Task 5 Channel Design - Channel - Inputs to get channel Depth

DISCHARGE CHANNEL

1. MANNING OUTPUT SECTION 3

OPEN CHANNEL DESIGN - STRICKLER'S EQUATION

ASSUMPTIONS & EQUATIONS Where K=Ave Flume Data (ACE 1994)

Mannings Value, n ~ K(D90)^0.16667

D90 of D50 = 7.8 inch Rock Particle Distribution = 12" (See Design Report For Gradation)

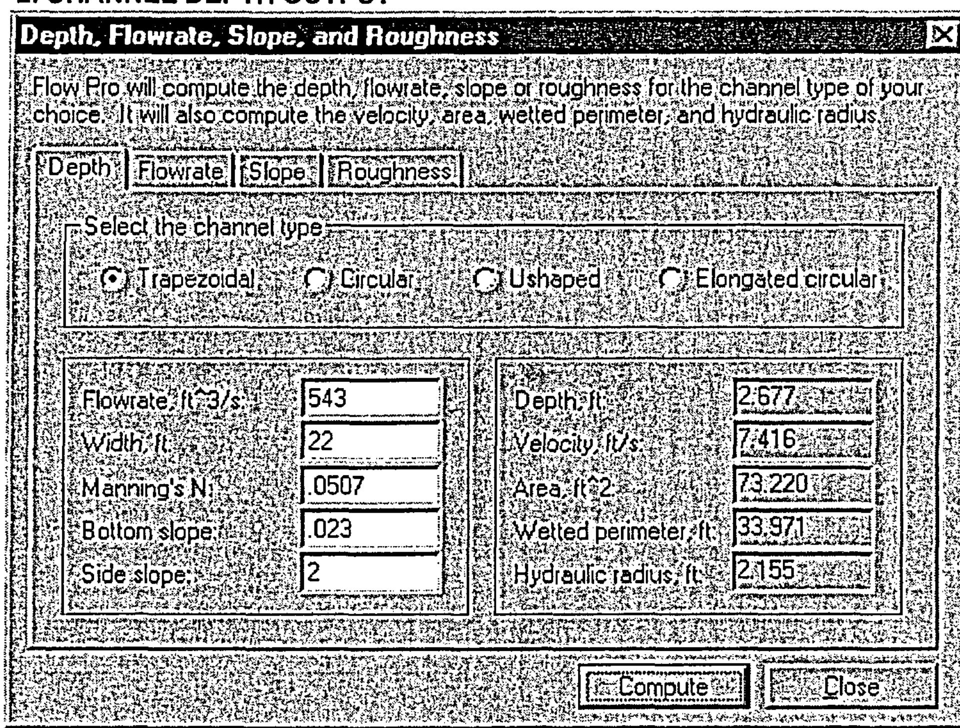
Note: Army Corp. of Engineers - Hydraulic Design of Flood Control Channels (1991)

CALCULATION: Using Army Corp. Of Engineers (ACE) Method (ACE, 1991)

Inputs	Value	Units
D50	7.8	inches

Output	Value	Units
n	0.0507	

2. CHANNEL DEPTH OUTPUT



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JOB NO. 1690030-500 **JOB TITLE** Rio Algom **DATE** 7/8/02 **BY** RLH

SUBJECT Channel Rock Sizing **CHECKED** ______ **SHEET** 1 **OF** 2

Rock Sizing Verification Using Steeper Slope / Smaller Flows
Channel Rock Size Calculations: (VERIFICATION)

STA 0+00 - 5+00 - For Check of Rock Size Determined w/ longer channel length ∴ large Flows

Method: NUREG 1623

Flow Calcs:

1) Parameters:

- Channel Length = 500 ft + 200 ft of Slope = 700 ft for t_c calcs
- Area To Drain Into Channel = 1.8 acres
- Change Elev. Del = 7020 - 6981 = 39 ft
- Design Slopes (For Rock Sizing)

5.5%

Note: Steeper Slope Used For Rock Sizing Channel Configuration developed for using flatter slope

2.) Time of Concentration:

$$t_c = \left[\left(11.9 \cdot \frac{(700/5280)^3}{39} \right) \right]^{0.385}$$

t_c = 0.06 hr = 2.5 min.

3.) Intensity, i:

Incremental Rainfall (Table 2.1, Nelson, 1986)

27.5% in 2.5 min PMP = (27.5%) x 9.6" = 2.64 in.

$$i = 60 \times \frac{2.64}{2.5} = 63.4 \text{ in/hr}$$

MAXIM TECHNOLOGIES INC

JOB NO. 1690030-500 **JOB TITLE** Rio Algom **DATE** 7/9/02 **BY** RLH

SUBJECT Channel Rock Sizing **CHECKED** ______ **SHEET** 2 **OF** 2

4.) Flow Q_i:

$Q = CiA$ (C = 1.0, Rock Covered Surface)

$Q = 1.0 \times 63.4 \times 1.8 = 114$ cfs

Q = 114 cfs

5.) Rock Sizing

Using Johnson · Abt et al (1993)

$D_{50} = 5.23 \times q_u^{0.56} \times S^{0.43}$

$q_u = Q/\text{width} = 114/12 = 9.5$ cfs/ft

$S = 5.5\%$

$D_{50} = 5.23 \times (9.5)^{0.56} \times (0.055)^{0.43}$

$D_{50} =$ **5.3 inches**

6.) Note: The $D_{50} = 5.3$ inch requirement is met for this section through the use of 7.5 in D_{50} Rock " determined in "Channel Calculation" attached previous to this section. The Rock Size results in the previous section, $D_{50} = 7.5$, exceeds the rock size required using the steeper slope of 5.5% through this section, do to the large flow quantity calculated in the previous section. Current channel config. is also adequate

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JOB NO. 1690030 JOB TITLE Rio Algom DATE 12/5/02 BY RLH

SUBJECT Riprap Size For D_{50}=7.5" CHECKED ________ SHEET 1 OF 1

Gradation Development of D_{50} = 7.8" (7.5" w/ oversize)

Use ACE, 1995 (Hydraulic Design of Flood Control Channels)

Table 3-1 Gradation For Riprap

D_{50} = 7.5" For Engineering Design

Rock Source Grading Per Rio Algom Samples = ~76%

* Per NRC Appx. D Sect. 7 Oversizing of Marginal Quality Rock

D_{50} = 7.5" x Oversize Factor

Oversize Factor = 80% - 76% = 4% (Per Section 7.2.2 - Oversize Criteria)

D_{50} = 7.5" x (1.04) = 7.8"

Riprap Gradation Specification For D_{50} = 7.8"

Sieve Size	% Passing
12"	100
9"	60 - 85
6"	5 - 30
4"	0 - 5

WHB
2/27/03

Rio Algom-Task 5, Scour Depth at Discharge Apron Outlet

For 1-hr. locl storm, PMP = 9.6"
Runoff Area = 19.8 Acres. Assume impermeable surface.

$$\text{Discharge} = \frac{9.6}{12} \times 19.8 \times 43560 = 690{,}000 \text{ ft}^3$$

$$\text{Runoff in 1 hr.,} \quad Q_{AVE} = \frac{690000}{3600\,\text{sec}} = 192 \text{ cfs ave. flow}$$

Use Abt et al (1996) scour equation to estimate scour depth:

$$d_s = R_h\, C_s \frac{\alpha}{\sigma^{1/3}} \left(\frac{Q}{g^{1/2}\, R_h^{5/2}}\right)^{\beta} \left(\frac{t}{316}\right)^{\theta}$$

where:

d_s = scour depth (ft)

R_h = hydraulic radius = 1.69 ft (see Worksheet)

C_s = slope coefficient = 1.01 for 1% slope

α = 2.27

β = 0.39

θ = 0.06

σ = coefficient of uniformity = 2.8

g = 32.2 ft/sec²

Q = 192 cfs ave. flow

t = 1 hr.

$$d_s = 1.69 \times 1.01 \frac{2.27}{2.8^{1/3}} \left(\frac{192}{32.2^{1/2} \times 1.69^{5/2}}\right)^{0.39} \left(\frac{1}{316}\right)^{0.06}$$

$$= \underline{4.6 \text{ ft.}}$$

Discharge Apron Outlet Condition
Worksheet for Trapezoidal Channel

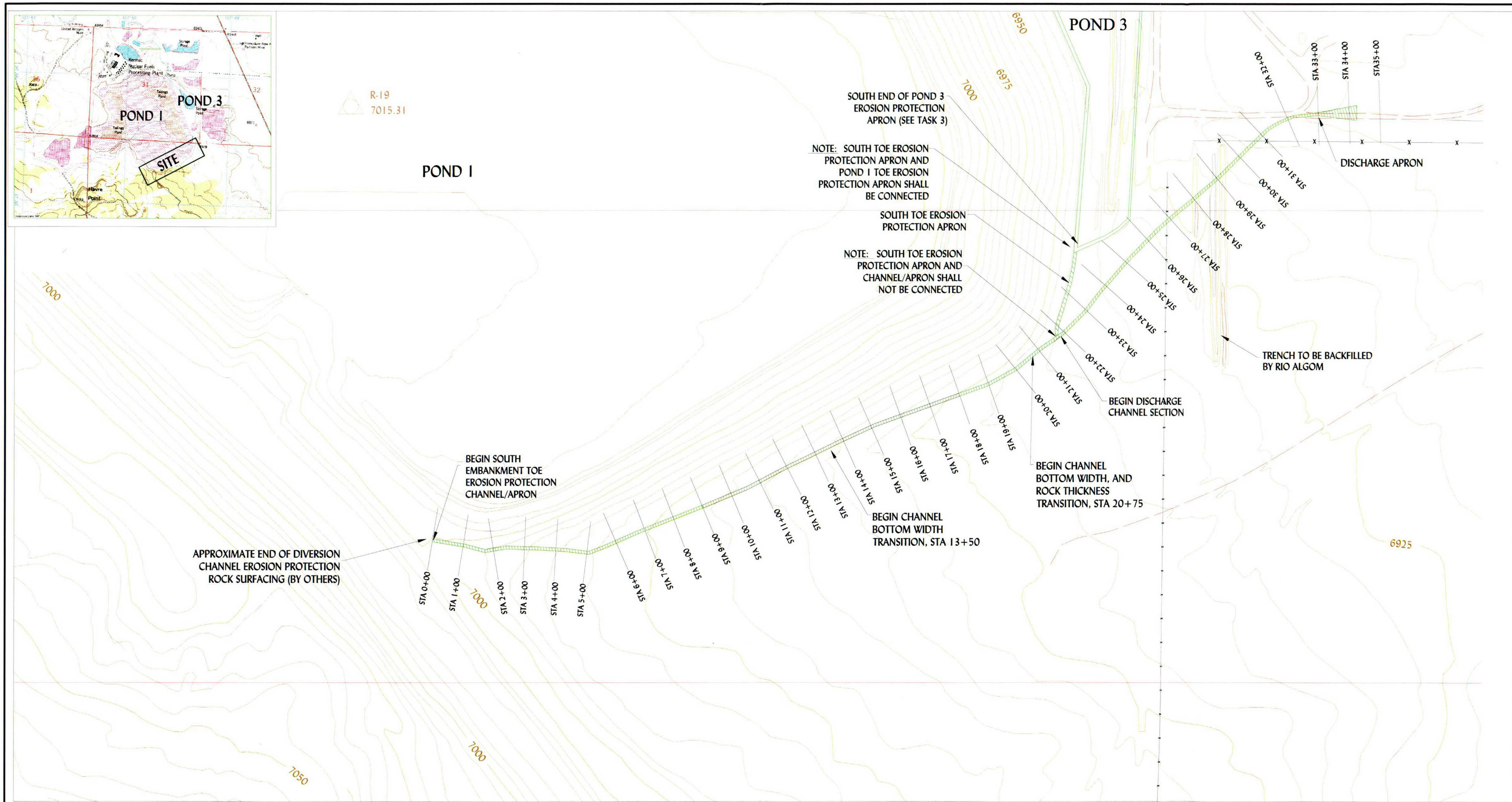
Project Description	
Project File	c:\haestad\fmw\quivira.fm2
Worksheet	Quivira
Flow Element	Trapezoidal Channel
Method	Manning's Formula
Solve For	Channel Depth

Input Data		
Mannings Coefficient	0.051	
Channel Slope	0.010000	ft/ft
Left Side Slope	2.000000	H : V
Right Side Slope	2.000000	H : V
Bottom Width	77.00	ft
Discharge	543.00	cfs

Results		
Depth	1.69	ft
Flow Area	135.86	ft^2
Wetted Perimeter	84.56	ft
Top Width	83.76	ft
Critical Depth	1.14	ft
Critical Slope	0.036902	ft/ft
Velocity	4.00	ft/s
Velocity Head	0.25	ft
Specific Energy	1.94	ft
Froude Number	0.55	
Flow is subcritical.		

APPENDIX D

DESIGN DRAWINGS



Notes: 1. Task 5 Consists of Three (3) Design Items; (See Item Areas Located On This Drawing)

A. An Erosion Protection Channel/Apron Constructed Along The Pond 1 South Embankment Toe (See Sheets 2, 3, 4 and 5)

B. A Discharge Channel At The End of The Channel/Apron Section With A Discharge Apron Constructed At The End of The Discharge Channel For Energy Dissipation In The Arroyo del Puerto Basin (See Sheets 6, 7 and 8).

C. An Erosion Protection Apron Along The Pond 1 Southern Portion of the East Embankment Toe (See Sheet 9 of 9)

2. The Erosion Protection Apron And the Erosion Protection Channel/Apron Shall Not Be Connected. The Apron Shall End At The Crest Of The Interior Embankment Slope Of The Erosion Protection Channel/Apron Near Station 21+75.

3. The Pond 1 Toe Erosion Protection Apron (Task 3 Apron) And The South Embankment Toe Erosion Protection Apron Shall be Connected.

4. The Horizontal Location Of The Above Noted Items For Erosion Protection Are Approximate. Field Adjustment To The Horizontal Location Of the Erosion Protection Channel/Apron, Toe Apron, And Discharge Apron May Be Necessary. The Erosion Protection Channel/Apron And Toe Apron Shall Be Placed At The Existing Toe Of Pond 1.

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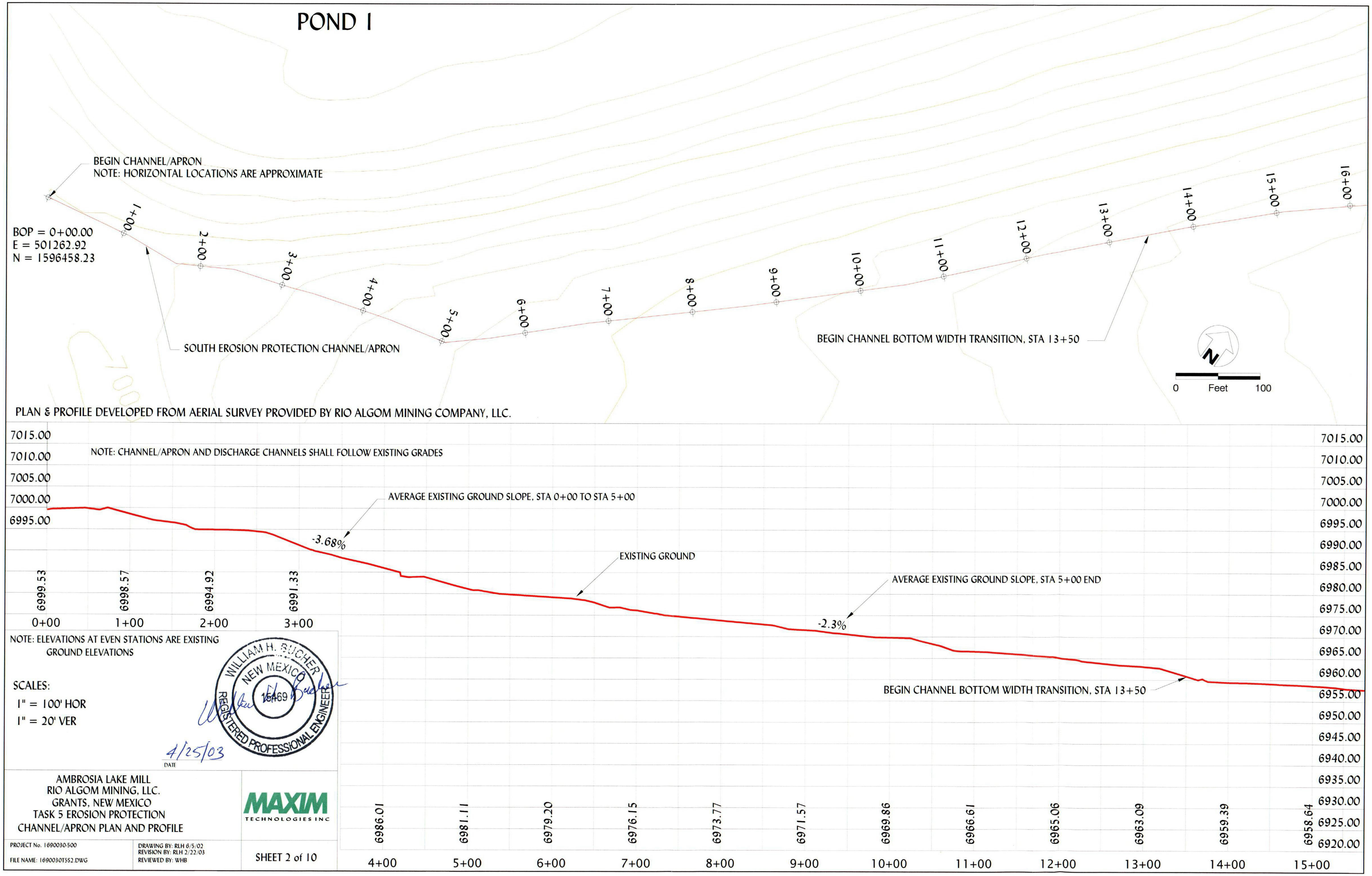
N
0 Feet 300

AMBROSIA LAKE MILL
RIO ALGOM MINING COMPANY, LLC.
GRANTS, NEW MEXICO
TASK 5 - EROSION PROTECTION
GENERAL EROSION PROTECTION PLAN

MAXIM TECHNOLOGIES INC

PROJECT No. 1690030-500	DRAWING BY: RLH 5/28/02 REVISION BY: RLH 2/21/03	SHEET 1 of 10
FILE NAME: 1690030T5S1.DWG	REVIEWED BY: WHB	

C01


POND 1
BEGIN CHANNEL/APRON
NOTE: HORIZONTAL LOCATIONS ARE APPROXIMATE
BOP = 0+00.00
E = 501262.92
N = 1596458.23
1+00
2+00
3+00
4+00
5+00
6+00
7+00
8+00
9+00
10+00
11+00
12+00
13+00
14+00
15+00
16+00
SOUTH EROSION PROTECTION CHANNEL/APRON
BEGIN CHANNEL BOTTOM WIDTH TRANSITION, STA 13+50
N
0
Feet
100
PLAN & PROFILE DEVELOPED FROM AERIAL SURVEY PROVIDED BY RIO ALGOM MINING COMPANY, LLC.
NOTE: CHANNEL/APRON AND DISCHARGE CHANNELS SHALL FOLLOW EXISTING GRADES
7015.00
7010.00
7005.00
7000.00
6995.00
6990.00
6985.00
6980.00
6975.00
6970.00
6965.00
6960.00
6955.00
6950.00
6945.00
6940.00
6935.00
6930.00
6925.00
6920.00
AVERAGE EXISTING GROUND SLOPE, STA 0+00 TO STA 5+00
-3.68%
EXISTING GROUND
AVERAGE EXISTING GROUND SLOPE, STA 5+00 END
-2.3%
BEGIN CHANNEL BOTTOM WIDTH TRANSITION, STA 13+50
6999.53
6998.57
6994.92
6991.33
0+00
1+00
2+00
3+00
6986.01
6981.11
6979.20
6976.15
6973.77
6971.57
6969.86
6966.61
6965.06
6963.09
6959.39
6958.64
4+00
5+00
6+00
7+00
8+00
9+00
10+00
11+00
12+00
13+00
14+00
15+00
NOTE: ELEVATIONS AT EVEN STATIONS ARE EXISTING GROUND ELEVATIONS
SCALES:
1" = 100' HOR
1" = 20' VER
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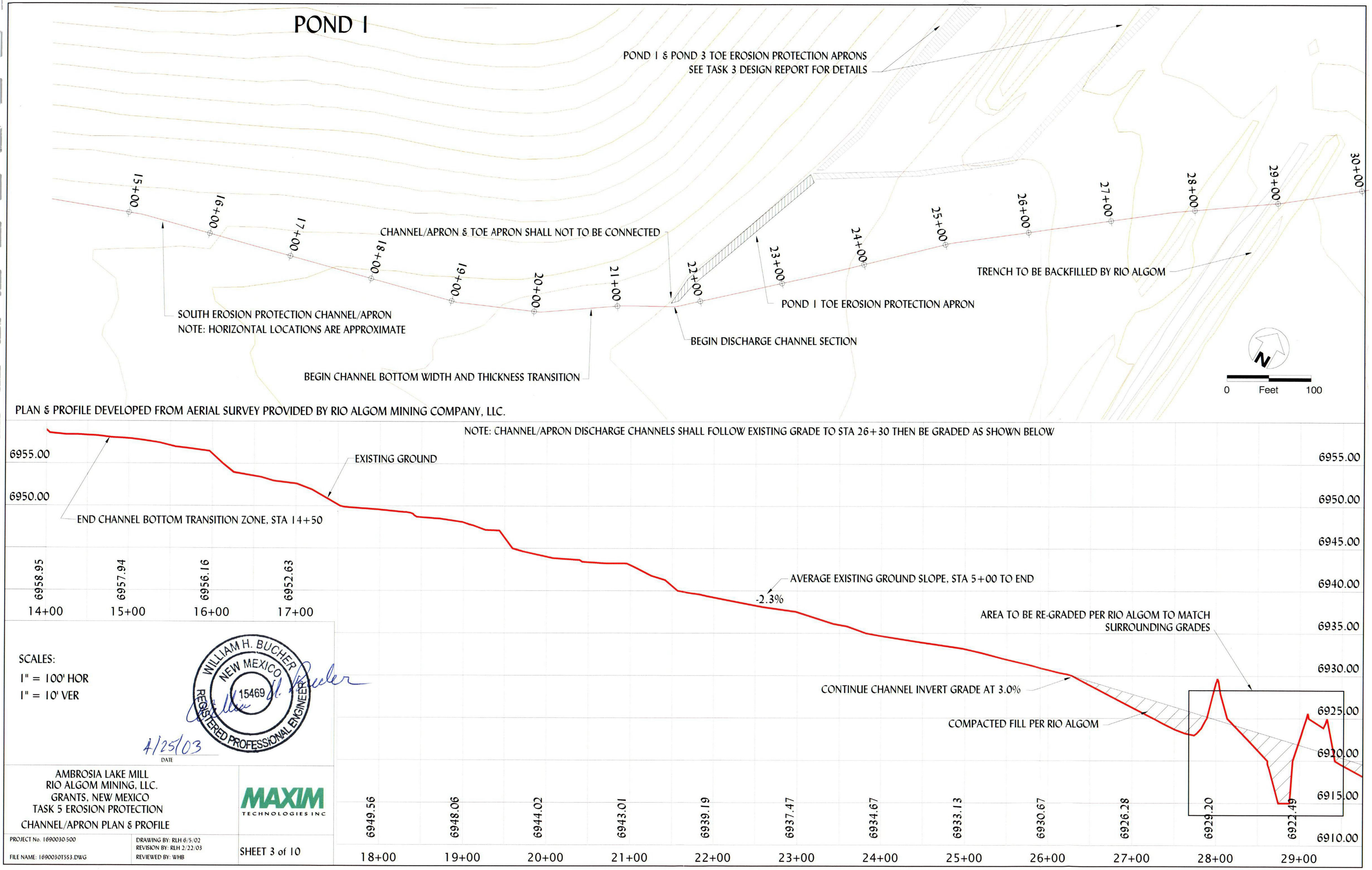
REGISTERED PROFESSIONAL ENGINEER
4/25/03
DATE
AMBROSIA LAKE MILL
RIO ALGOM MINING, LLC.
GRANTS, NEW MEXICO
TASK 5 EROSION PROTECTION
CHANNEL/APRON PLAN AND PROFILE
MAXIM
TECHNOLOGIES INC
PROJECT No. 1690030-500
FILE NAME: 1690030TSS2.DWG
DRAWING BY: RLH 6/5/02
REVISION BY: RLH 2/22/03
REVIEWED BY: WHB
SHEET 2 of 10

C02


POND 1
POND 1 & POND 3 TOE EROSION PROTECTION APRONS
SEE TASK 3 DESIGN REPORT FOR DETAILS
15+00
16+00
17+00
18+00
19+00
20+00
21+00
22+00
23+00
24+00
25+00
26+00
27+00
28+00
29+00
30+00
CHANNEL/APRON & TOE APRON SHALL NOT TO BE CONNECTED
TRENCH TO BE BACKFILLED BY RIO ALGOM
POND 1 TOE EROSION PROTECTION APRON
SOUTH EROSION PROTECTION CHANNEL/APRON
NOTE: HORIZONTAL LOCATIONS ARE APPROXIMATE
BEGIN DISCHARGE CHANNEL SECTION
BEGIN CHANNEL BOTTOM WIDTH AND THICKNESS TRANSITION
N
0 Feet 100
PLAN & PROFILE DEVELOPED FROM AERIAL SURVEY PROVIDED BY RIO ALGOM MINING COMPANY, LLC.
NOTE: CHANNEL/APRON DISCHARGE CHANNELS SHALL FOLLOW EXISTING GRADE TO STA 26+30 THEN BE GRADED AS SHOWN BELOW
6955.00
6950.00
6945.00
6940.00
6935.00
6930.00
6925.00
6920.00
6915.00
6910.00
EXISTING GROUND
END CHANNEL BOTTOM TRANSITION ZONE, STA 14+50
AVERAGE EXISTING GROUND SLOPE, STA 5+00 TO END
-2.3%
AREA TO BE RE-GRADED PER RIO ALGOM TO MATCH SURROUNDING GRADES
CONTINUE CHANNEL INVERT GRADE AT 3.0%
COMPACTED FILL PER RIO ALGOM
6958.95
6957.94
6956.16
6952.63
14+00
15+00
16+00
17+00
6949.56
6948.06
6944.02
6943.01
6939.19
6937.47
6934.67
6933.13
6930.67
6926.28
6929.20
6922.49
18+00
19+00
20+00
21+00
22+00
23+00
24+00
25+00
26+00
27+00
28+00
29+00
SCALES:
1" = 100' HOR
1" = 10' VER
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4/25/03
DATE
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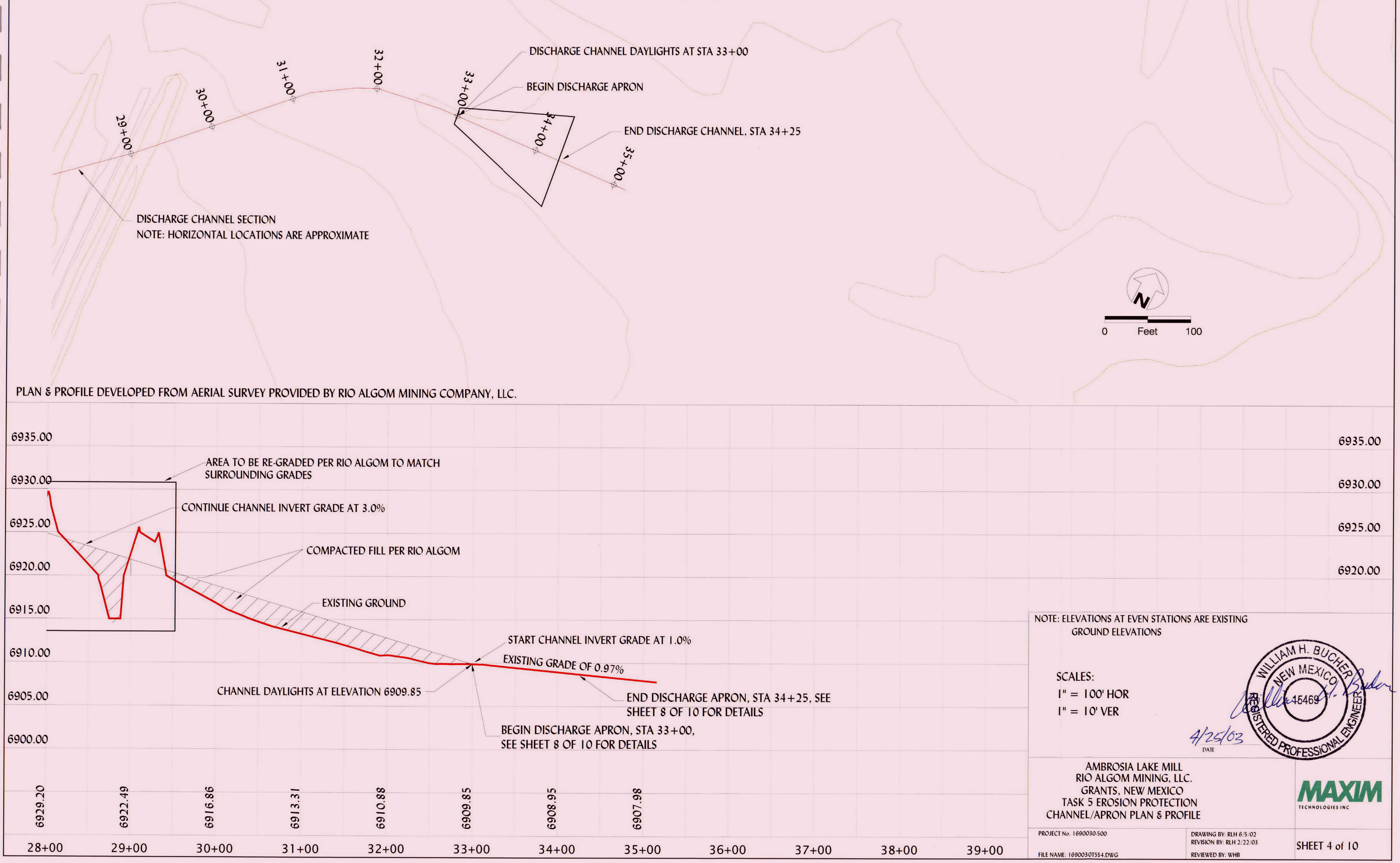
GRANTS, NEW MEXICO
TASK 5 EROSION PROTECTION
CHANNEL/APRON PLAN & PROFILE
MAXIM
TECHNOLOGIES INC
PROJECT No. 1690030.500
FILE NAME: 1690030TS53.DWG
DRAWING BY: RLH 6/5/02
REVISION BY: RLH 2/22/03
REVIEWED BY: WHB
SHEET 3 of 10

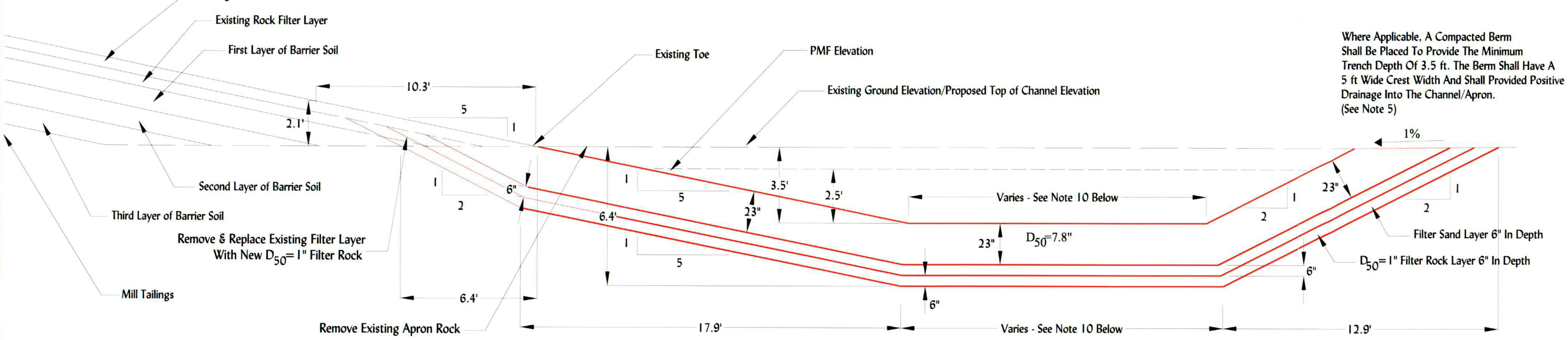
C03

ARROYO DEL PUERTO BASIN



C04

CHANNEL/APRON SECTION



CONSTRUCTION NOTES:

1. The Pond 1 erosion protection channel/apron shall be constructed such that it replaces the existing Pond 1 internal apron. Estimated length of channel/apron is 3,300 ft. See Sheet 1 for approximate channel/apron start and end points.

2. The existing internal apron of the Pond 1 embankment shall be removed and replaced as shown above such that the apron shall provide positive drainage into the newly constructed channel/apron.

3. The bottom of the channel/apron shall be constructed flat from side slope to side slope to prevent concentrated flows.

4. Rock Riprap for erosion protection shall be placed in conformance with Appendix F of *Design of Erosion Protection for Long-Term Stabilization*, U.S. Nuclear Regulatory Commission's NUREG -CR1623 Draft Report unless otherwise specified in the Pond 1 Embankment Toe Erosion Protection Report or the included Design Drawings.

5. Where applicable, compacted fill may be placed on the exterior to construct an embankment that will provide the minimum 3.5 ft of depth for the channel/apron. The fill required to construct the embankment shall consist of material excavated from within the channel/apron trench or other on-site borrow sources. The fill shall be compacted to a minimum of 95% of maximum density as determined by ASTM D-698 and within +/- 2% of optimum moisture content. Each lift of fill shall not exceed a loose thickness of 10 inches. The embankment shall maintain the 2H:1V slope on its interior and a 5H:1V or flatter slope on the exterior. The embankment shall have a crest width of not less than 5 ft.

6. The channel/apron excavation shall be constructed with bottoms free of loose debris, vegetation and muddy surfaces.

7. The erosion protection bedding/filter material shall be placed at a minimum thickness of 6" along the length of the channel/apron. The bedding/filter material shall extend up the 2H:1V side slopes and end flush with the existing ground elevation or erosion protection rock as shown above. Bedding/filter materials shall be spread and compacted in one layer.

8. Existing erosion protection rock disturbed during construction of the channel/apron shall be replaced such as to maintain existing slopes and riprap conditions as approved previously by the U.S. Nuclear Regulatory Commission. Care shall be taken in removing and stockpiling the riprap such that the material is not degraded or otherwise damaged. Rock degraded or otherwise not in conformance with the NUREG 1623 due to removal and replacement methods shall be replaced with similar approved materials. Care shall be taken such that existing tailings are not disturbed during erosion protection channel/apron construction.

9. The channel/apron shall be covered with a minimum of 23" of d_{50}=7.8" rock. The rock shall be extended up the side slopes to the existing grade on the exterior and interlock with the existing interior rock placed on the Pond 1 embankment slope as shown above.

10. Section 1 of the channel/apron, STA 0+00 to STA 13+50 shall be constructed with an excavation bottom width of 15.1 ft and a channel bottom width of 14.0 ft. Section 2 of the channel/apron, STA 14+50 to STA 21+75, shall have an excavation bottom width of 19.1 ft and a channel bottom width of 18.0 ft. All other dimensions remain the same. See Sheet 8 for details on Section 3, STA 21+75 to end. See Sheet 6 for transition detail from STA 13+50 to STA 14+50.

10. The channel/apron erosion protection rock shall be constructed of a rock diameter d_{50}=7.8" conforming to the following gradation:

Sieve Designation	Percent Passing
12"	100
9"	60 - 85
6"	5 - 30
4"	0 - 5

11. The channel/apron erosion protection rock shall be constructed on 6" of bedding/filter rock of diameter d_{50}= 1" conforming to the following gradation:

Sieve Designation	Percent Passing
3"	100
2"	80 - 90
3/4"	20 - 70
3/8"	10 - 30
No.4	0 - 10

12. The channel/apron erosion protection filter rock shall be constructed on 6" of bedding/filter sand conforming to the following gradation:

Sieve Designation	Percent Passing
No.4	100
No.10	80 - 100
No.20	36 - 76
No.40	10 - 20
No.100	0 - 10

4/25/03
DATE

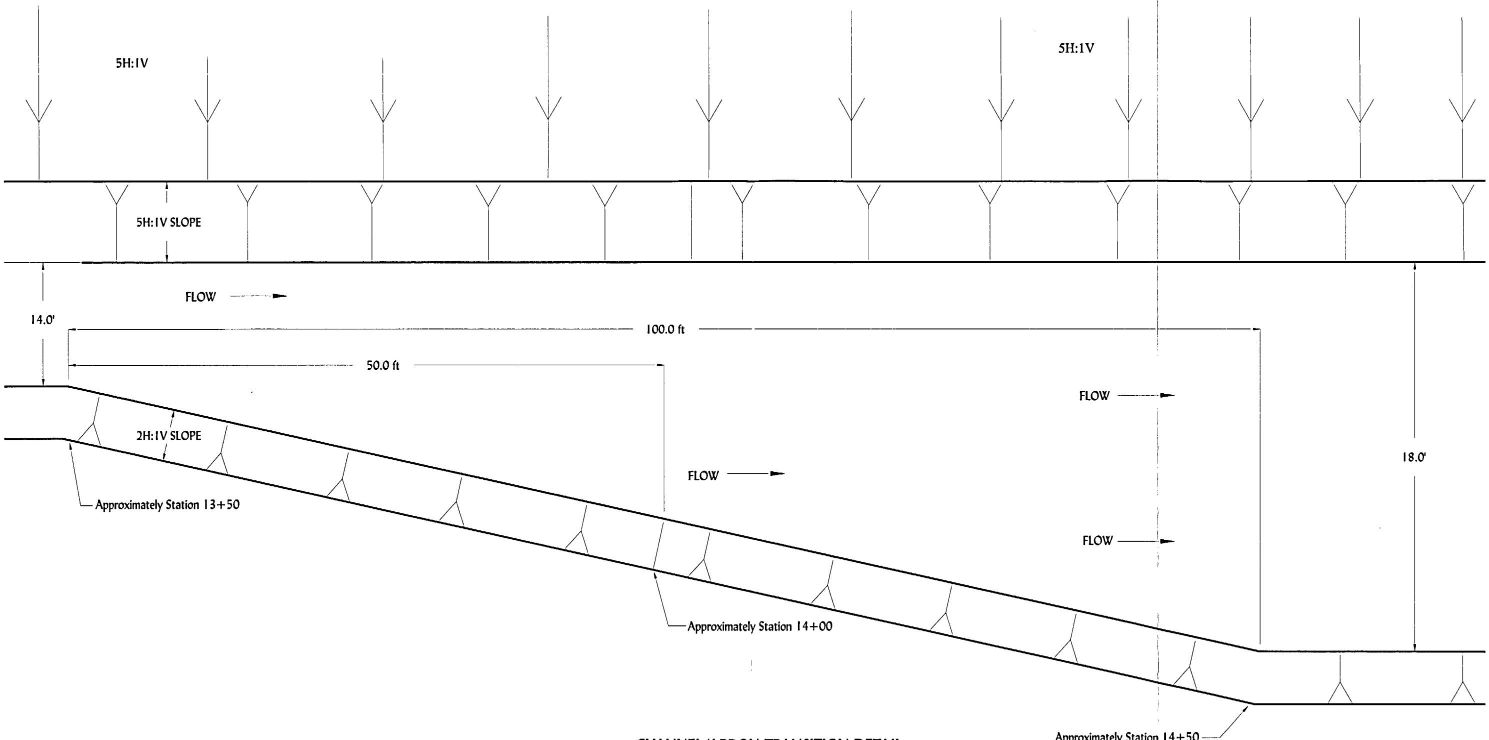
SCALE: 1 in = 5 ft

AMBROSIA LAKE MILL
RIO ALGOM MINING COMPANY, LLC.
GRANTS, NEW MEXICO
TASK 5 EROSION PROTECTION
EMBANKMENT TOE CHANNEL/APRON SECTION

MAXIM TECHNOLOGIES INC

PROJECT No. 1690030-500	DRAWING BY: RLH 6/5/02 REVISION BY: RLH 2/27/03
FILE NAME: 1690030T5S5.DWG	REVIEWED BY: WHB

C05



CHANNEL/APRON TRANSITION DETAIL

Not To Scale

CONSTRUCTION NOTES:

1. The upper channel/apron configuration shall transition to the lower channel/apron configuration in 100.0 ft.
2. The channel/apron bottom shall be constructed flat such that flow is evenly distributed across the channel bottom.

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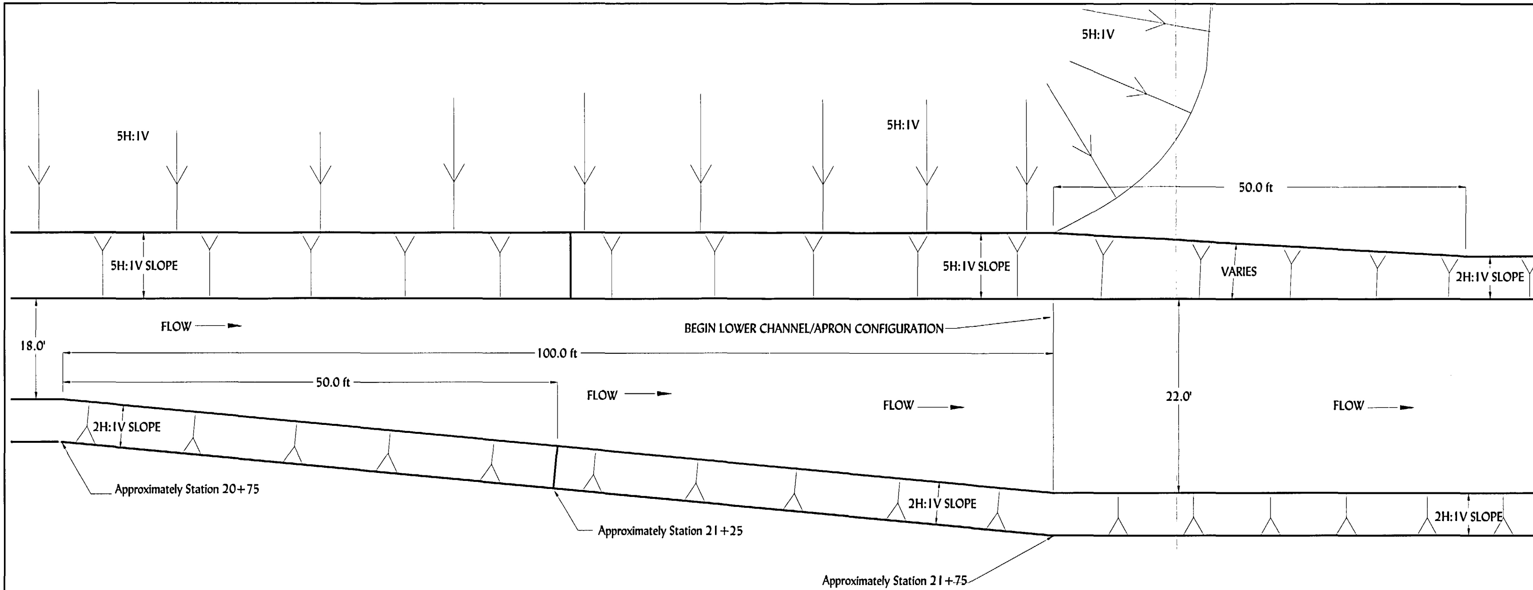
TASK 5 EROSION PROTECTION
TRANSITION SECTION, STA 13+50 to STA 14+50

MAXIM TECHNOLOGIES INC

PROJECT No. 1690030-500	DRAWING BY: RLH 2/27/03	SHEET 6 of 10
FILE NAME: 1690030T5S6.DWG	REVIEWED BY: WHB	



CHANNEL/APRON TRANSITION DETAIL

Not To Scale

CONSTRUCTION NOTES:

1. The upper channel/apron configuration shall transition to the lower channel/apron configuration in 100.0 ft. The rip rap thickness design shall conform to the lower channel apron design at STA 21+75 of the transition section.
2. The channel/apron bottom shall be constructed flat such that flow is evenly distributed across the channel bottom.
3. The left side channel/apron slope shall transition from the 5H:1V slope to the 2H:1V slope in 50 ft starting at the point where the embankment toe seperates from the channel/apron, approximately STA 21+75.

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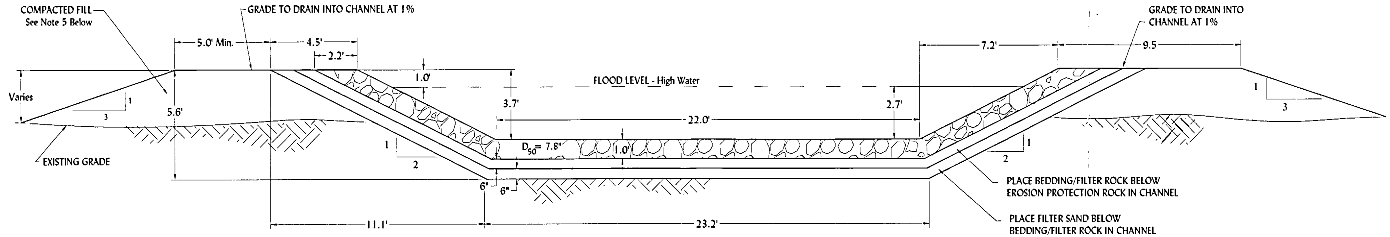
TASK 5 EROSION PROTECTION
TRANSITION SECTION, STA 20+75 to STA 22+25

MAXIM TECHNOLOGIES INC

PROJECT No. 1690030-500	DRAWING BY: RLH 2/27/03	SHEET 7 of 10
FILE NAME: 1690030T5S7.DWG	REVIEWED BY: WHB	



DISCHARGE CHANNEL TYPICAL SECTION

STA 21+75 TO STA 33+00

SCALE: 1 in = 5 ft

NOTES:

1. Rock Riprap for erosion protection shall be placed in conformance with Appendix F of *Design of Erosion Protection for Long-Term Stabilization*, U.S. Nuclear Regulatory Commission's NUREG -CR1623 Draft Report unless otherwise specified in the TASK 5 Erosion Protection Report or the included Design Drawings.
2. The bottom of the channel shall be constructed flat from side slope to side slope to prevent concentrated flows.
3. The channel excavation shall be constructed with bottoms free of loose debris, vegetation and muddy surfaces.
4. Areas disturbed during construction of the channel, shall be revegatated
5. Where applicable, compacted fill may be placed on the exterior to construct an embankment that will provide the minimum channel depth. The fill required to construct the embankment shall consist of material excavated from within the channel/apron trench or on-site borrow areas. The fill shall be compacted to a minimum of 95% of maximum density as determined by ASTM D-698 and within +/- 2% of optimum moisture content. Each lift of fill shall not exceed a loose thickness of 10 inches. The embankment shall maintain the 2H:1V slope on its interior and a 3H:1V or flatter slope on the exterior. The embankment shall have a crest width of not less than 5 ft.
6. The erosion protection bedding/filter material shall be placed at a minimum thickness of 6" along the length of the channel. The bedding/filter material shall extend up the 2H:1V side slopes to the existing grade or berm crest, which ever is greater. Bedding/filter materials shall be spread and compacted in one layer.
7. The channel shall be constructed with a minimum of 12" of d_{50}=7.8" rock. The rock shall be extended up the side slopes to the existing grade on the exterior and interlocked with the existing rock placed for surface erosion protection on the south side of the diversion channel.

9. The channel erosion protection rock shall be constructed of a rock diameter d_{50} =7.8" conforming to the following gradation:

Sieve Designation	Percent Passing
12"	100
9"	60 - 85
6"	5 - 30
4"	0 - 5

10. The channel/apron erosion protection rock shall be constructed on 6" of bedding/filter rock and 6" of filter sand conforming to the following gradation:

Bedding/Filter Gravel (d_{50}=1.0")

Sieve Designation	Percent Passing
3"	100
2"	80 - 90
3/4"	20 - 70
3/8"	10 - 30
No.4	0 - 10

Filter Sand

Sieve Designation	Percent Passing
No. 4	100
No. 10	80 - 100
No. 20	36 - 76
No. 40	10 - 20
No. 100	0 - 10

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NEW MEXICO
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REGISTERED PROFESSIONAL ENGINEER

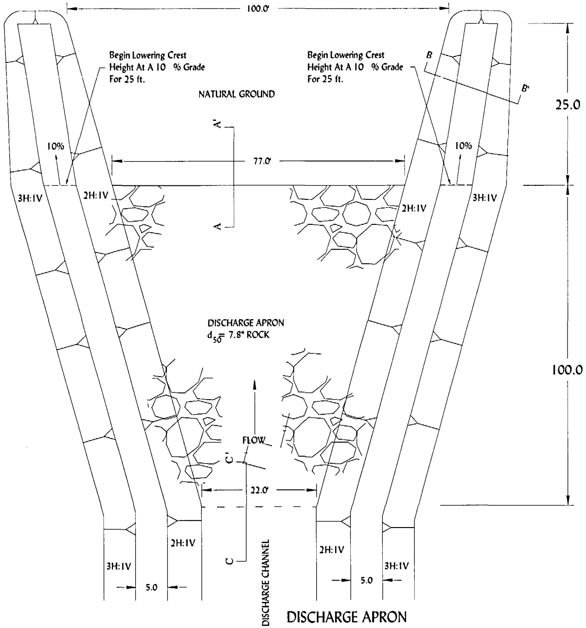
William H. Bucher

4/25/03
DATE

AMBROSIA LAKE MILL
RIO ALGOM MINING COMPANY, LLC.
GRANTS, NEW MEXICO
TASK 5 EROSION PROTECTION
DISCHARGE CHANNEL SECTION

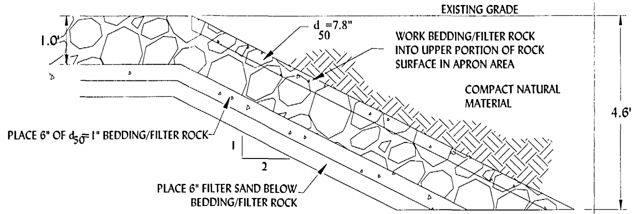
MAXIM TECHNOLOGIES INC

PROJECT No. 1690030-500	DRAWING BY: RLH 2/27/03	SHEET 8 of 10
FILE NAME: 16900301558.DWG	REVIEWED BY: WHB	



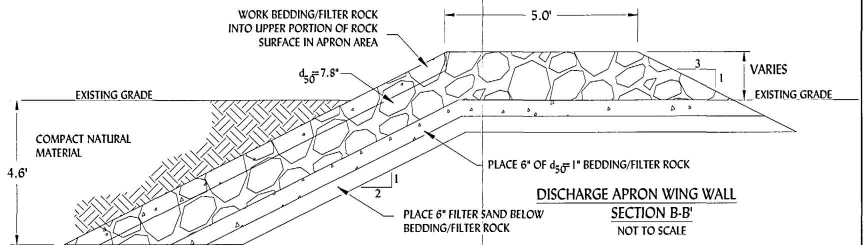
DISCHARGE APRON PLAN VIEW

NOT TO SCALE



DISCHARGE APRON TOE SECTION A-A'

NOT TO SCALE

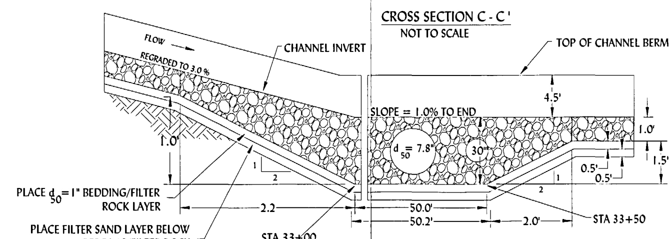


DISCHARGE APRON WING WALL SECTION B-B'

NOT TO SCALE

CROSS SECTION C - C '

NOT TO SCALE



NOTES:

1. Rock Riprap for erosion protection shall be placed in conformance with Appendix F of Design of Erosion Protection for Long-Term Stabilization, U.S. Nuclear Regulatory Commission's NUREG -CR1623 Draft Report unless otherwise specified in the TASK 5 Erosion Protection Report or the included Design Drawings.
2. The bottom of the channel shall be constructed flat from side slope to side slope to prevent concentrated flows.
3. The channel excavation shall be constructed with bottoms free of loose debris, vegetation and muddy surfaces.
4. Apron erosion protection rock shall be tied into the discharge channel rock. Areas disturbed during construction of the apron shall be revegatated
5. The erosion protection bedding/filter material shall be placed at a minimum thickness of 6" along the length of the apron. The bedding/filter material shall extend up the 2H:1V side slopes to the existing grade and end below the erosion protection rock layer on the side slopes and crests as shown above. Bedding/filter materials shall be spread and compacted in one layer.
6. The apron shall be constructed with a minimum of 12" of d_{50}=7.8" rock.
7. The height of the wing wall varies from 3.7 ft at the end of the rock apron to approximately 2 ft at the end of the wing-wall.
8. The channel erosion protection rock shall be constructed of a rock diameter d_{50}=7.8" conforming to the following gradation:

Sieve Designation	Percent Passing
12"	100
9"	60 - 85
6"	5 - 30
4"	0 - 5

9. The apron erosion protection rock shall be constructed on 6" of bedding/filter rock and 6" of filter sand conforming to the following gradation:

Bedding/Filter Gravel (d_{50}= 1.0")		Filter Sand	
Sieve Designation	Percent Passing	Sieve Designation	Percent Passing
3"	100	No. 4	100
2"	80 - 90	No. 10	80 - 100
3/4"	20 - 70	No. 20	36 - 76
3/8"	10 - 30	No. 40	10 - 20
No.4	0 - 10	No. 100	0 - 10

4/25/03
DATE

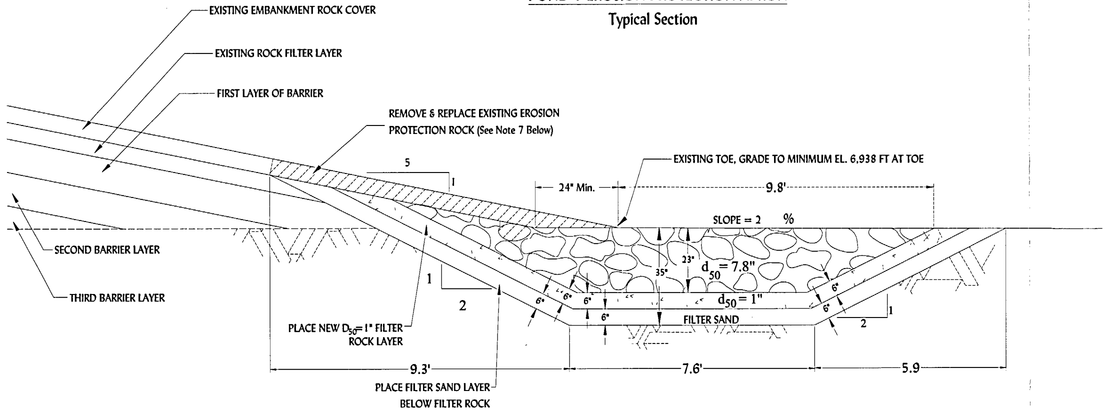
AMBROSIA LAKE MILL
RIO ALGOM MINING COMPANY, LLC.
GRANTS, NEW MEXICO
TASK 5 EROSION PROTECTION
DISCHARGE APRON

MAXIM TECHNOLOGIES INC

PROJECT No. 1690030-500	DRAWING BY: RLH 6/1/02 REVISION BY: RLH 2/22/03	SHEET 9 of 10
FILE NAME: 1690030T5S9.DWG	REVIEWED BY: WHB	

POND 1 EROSION PROTECTION APRON

Typical Section



NOTES:

1. Rock Riprap for erosion protection aprons shall be placed in conformance with Appendix F of *Design of Erosion Protection for Long-Term Stabilization*, U.S. Nuclear Regulatory Commission's NUREG - 1623 Draft Report unless otherwise specified in the Task 5 Erosion Control Design Report or the Design Drawings.
2. Erosion protection aprons shall be sloped to the downstream edge with a minimum slope of two percent or at a slope that matches the slope of the natural ground, should it be steeper than two percent.
3. Erosion protection apron excavations shall be constructed with 2H:1V slopes to permit placement of the filter materials as shown above.
4. The erosion protection apron shall be constructed of a rock diameter d_{50}= 7.8" conforming to the following gradation:

Sieve Designation	Percent Passing
12"	100
9"	60 - 85
6"	5 - 30
4"	0 - 5

5. Each layer of erosion protection bedding/filter material shall be placed at a minimum thickness of 6" along the length of the apron. The bedding/filter material shall extend up the 2V:1H sides and end below the Pond 3 erosion protection rock. Bedding/filter material shall be spread and compacted in one layer.
6. Erosion protection apron riprap bedding/filter material shall meet the following gradation:

Filter Gravel

Sieve Designation	Percent Passing
3"	100
2"	80 - 100
3/4"	20 - 70
3/8"	10 - 30
No.4	0 - 10

Filter Sand

Sieve Designation	Percent Passing
No.4	100
No. 10	80 - 100
No. 20	36 - 76
No. 40	10 - 20
No.100	0 - 10

7. Existing erosion protection disturbed during construction of the erosion protection aprons shall be replaced in a manner that maintains existing slopes and riprap conditions as approved previously by the U.S. Nuclear Regulatory Commission. Care shall be taken in removing and stockpiling the riprap such that the material is not degraded or otherwise damaged. Rock degraded or otherwise out of conformance with the NUREG 1623 due to removal and replacement methods shall be replaced with similar approved materials. Care should be taken so that existing tailings are not disturbed during erosion protection apron construction.
8. The erosion protection apron shall be constructed continuously from the south embankment erosion protection channel/apron (southeast corner of Pond 1) to the southwest limits of Pond 3. The erosion protection apron shall be connected at the north end to the proposed Pond 1 to Pond 3 erosion protection apron. The south end of the erosion protection apron shall NOT be connected to the south embankment erosion protection channel/apron. The apron shall end at the crest of the interior slope of the south embankment erosion protection channel/apron.
9. The erosion protection apron shall be constructed level from the north end to the south end to prevent longitudinal flows within the apron. The erosion protection apron shall be constructed such that flow from the embankment will flow perpendicular to the apron and onto the downstream side where it will drain away from the erosion protection apron.

1 in = 3 ft

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4/25/03
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AMBROSIA LAKE MILL
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GRANTS, NEW MEXICO
TASK 5 EROSION PROTECTION
POND 1 TOE EROSION PROTECTION APRON

MAXIM TECHNOLOGIES INC

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SHEET 10 of 10

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