Offices:

Colorado

Wyoming

Montana

Arizona

North Dakota

Oregon

Washington

Alaska

DESIGN REPORT
GOLDEN WONDER MINE PROJECT
HINSDALE COUNTY, COLORADO

MAY 10, 2017

Prepared for:

LKA International
Attention: Kye Abraham
3724 47th Street Ct. NW
Gig Harbor, WA 98335

DOWL
Consulting Engineers
222 S. Park Ave. Montrose, Colorado 81401
(970) 249-6828 Ph. (970) 249-0945 Fax
www.dowl.com

DOWL

TABLE OF CONTENTS

1.0 INTRODUCTION

This report is prepared for LKA International, Inc. (LKA), in response to paragraphs 28 and 30 of Notice of Violation/Cease and Desist Order Number 10-170317-1 (NOV-CDO), which the Colorado Department of Public Health and Environmental (CDPHE) issued to LKA on March 29, 2017, as amended by Amendment Number One of the NOV-CDO, dated May 1, 2017.

1.1 Project Location

The Golden Wonder Mine is an underground gold mine located at approximately 9,800 feet above MSL at Latitude 38.003361 North, Longitude 107.282854 West in Hinsdale County, Colorado.

1.2 Existing Conditions

The amount of groundwater day-lighting near the waste rock pile beneath the level 6 pad and from the level 6 portal of the Golden Wonder Mine has increased to a point where an existing limestone sump used to treat the water cannot effectively increase the pH of the drainage to an acceptable level. Limestone boulders placed above the 24-inch HDPE bypass for Deadman Gulch drainage have become coated and are no longer effective in neutralizing acid in the water. Exhibit 1 in Appendix A of this report describes the existing mitigation system components at the mine. Figure 1 below presents an aerial image of the Level 6 pad for reference.

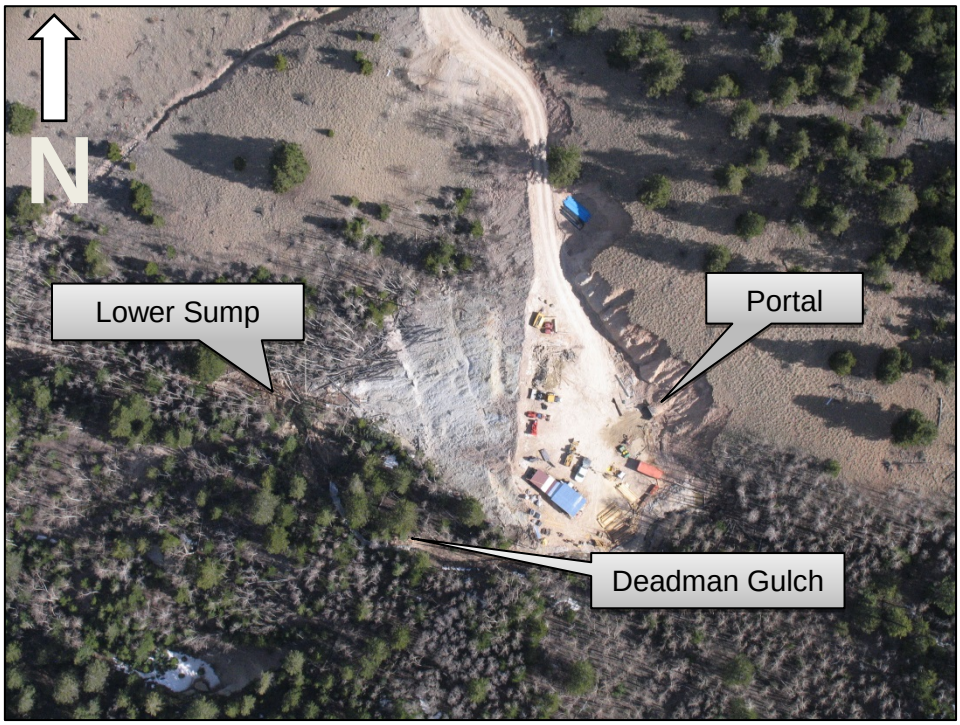


Figure 1. Aerial view of Golden Wonder Mine – Level 6 pad. Image from Google Earth©

Over the years, several materials have been used or proposed for use to mitigate acid levels and balance the pH values in the water. Materials have included, soda ash, crushed limestone and zeolite minerals. We reviewed available mitigation data and proposed using steel slag from the Harsco Metals and Materials of Pueblo, Colorado to neutralize the acid in the water and provide effluent that meets the requirements of Colorado Discharge Permit System, Permit No. C00048119 (Discharge Permit).

In 2008 DOWL, as Buckhorn Geotech, assisted Black Creek Hydrology in the design and construction of a 24-inch HDPE bypass pipe to convey seasonal Deadman Gulch runoff flow past the Level 6 pad. The HDPE pipe was buried in a trench from the Level 6 pad elevation to the lower sump elevation and 18+ inch limestone boulders were placed on top of the buried pipe to created a treatment channel. The system was effective in neutralizing acid in the water and increasing the pH of effluent until the boulders became clogged with residue and the system became less effective. Crushed limestone placed in the lower sum also proved effective for several years until it too became clogged with residue.

Figure 2. View of current mitigation at lower sump using crushed limestone in an EPDM lined sump with concrete headwalls and 0.5-foot H-flume (out of view to the right). Note 24-inch HDPE discharge pipe and wooden directional flume for Deadman Gulch bypass flow. Photo by Wayne Pandorf (DOWL) on August 5, 2016.

1.3 Design Objectives

Based on issues with achieving the effluent water quality requirements of the Discharge Permit, presented in Appendix B of this report, DOWL was engaged by LKA to provide mitigation alternatives to the current crushed limestone method. Additionally, this report is intended to recommend improved sampling, monitoring and reporting equipment and techniques to monitor the treated effluent and provide data for required reporting to CDPHE.

2.0 PROPOSED IMPROVEMENTS

2.1 Design Criteria

As a basis for designing new passive treatment, DOWL used flow data from project hydrologist Steve Belz of Black Creek Hydrology and chemical analysis of a steel slag treatment analyses performed by Liese Thompson of Enviro-Chem Analytical. Steve has measured seepage flows

for several years at the mine and that data is included in Appendix C of this report. A maximum flow of 5 gpm was used based on those flow records. Based on the information from Enviro-Chem, we used a maximum retention time in the proposed slag material of 1 hour. Further exposure to the slag actually decreased the pH and, as noted in the Enviro-Chem Steel Slag Study in Appendix D, tended to increase the amount of leachate precipitated and which could potential clog the porous steel slag and reduce efficacy.

2.2 Previous Studies

The use of steel slag to provide neutralization was suggested by our review of successful laboratory testing performed by Ziemkiewicz and Skousen. Additionally, we reviewed a separate study performed in Brazil that successfully neutralized acid mine drainage from a uranium mine using steel slag. Both studies are referenced in Section 5.0. Producers of steel slag, including TIMS and Harsco, have documented successful use of steel slag for treatment of acid mine drainage. Links to their websites are included in Section 5.0

Benefits of steel slag versus limestone include:

- Slag does not clog or armor over with precipitate like limestone
- Steel slag produces alkalinity concentrations that range from 1,000 to 4,000 mg/l versus concentrations of 80-100 mg/l for limestone
- Slag does not tend to produce CO_2 like limestone does, which reduces green-house gas emissions
- Limestone is more expensive than slag which is a by-product of the steel making industry.
- Using slag recycles a waste product instead of requiring extraction and reclamation of limestone mines.

Observations of the armoring of limestone boulders with precipitate at the Golden Wonder Mine support the use of steel slag as an effective treatment alternative. Typical chemical composition of steel slag from TIMS is presented in Figure 3 below.

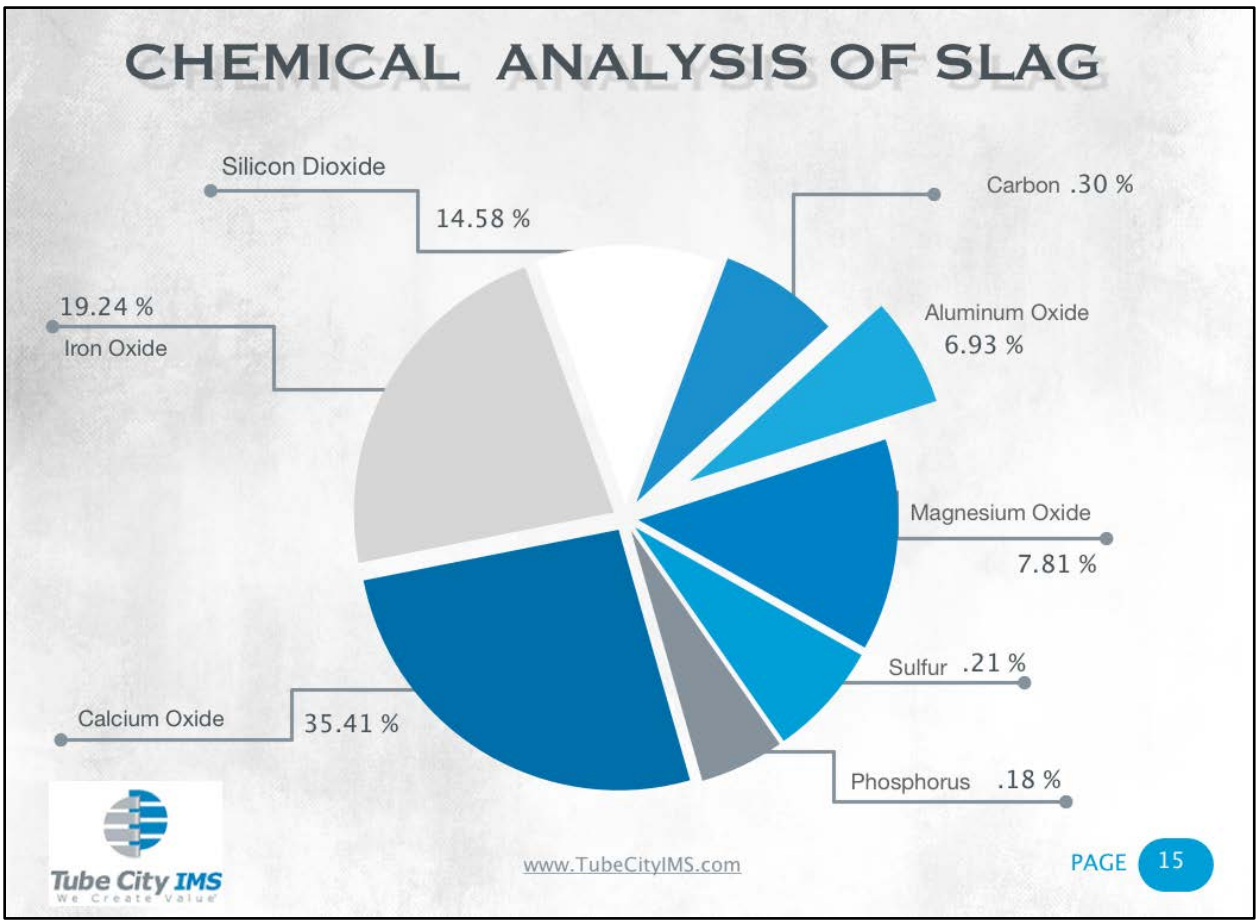


Figure 3. Typical chemical composition of steel slag from Tube City IMS (now TIMS).

2.3 Options Analysis

After initial review of the bench testing performed by Enviro-Chem, we examined several alternative filter arrangements with the proposed R-slag material to try and duplicate laboratory results in the system design. Options included:

1. Trapezoidal horizontal Smart Trench® slag filter with downstream settling basin – This option is based on the proposed design in Ziemkiewicz's study but would require too long a filter train at 1% grade to achieve exposure times similar to those recommended by Enviro-Chem in their analysis. Due to the ribbed nature of the Smart Trench® sections, we determined that rotation of the slag and cleaning of the precipitate would be difficult and time consuming. Option 1 was rejected for the reasons listed.

2. Semi-circular horizontal Smart Trench® slag filer with downstream settling basin – This option was rejected for the same reasons as Option 1. We considered screens or grates at the bottom of both trapezoidal and semi-circular trench sections to retain slag above and precipitate below, but cleaning the sections would be, in our opinion, difficult and time consuming.

3. Vertical, exchangeable slag filter – This option would provide treatment through the R-slag filter media to simulate successful laboratory conditions. This option would allow for the use of multiple filters as needed, rapid replacement and ease of cleaning of the precipitate. Due to demonstrated efficacy, ease of media exchange and precipitate

cleaning and space constraints on the Level 6 pad, this option was selected for our design. More details are provided in Section 2.3 below and in the design plans presented in Appendix F of this report.

2.4 Calculations

Bench testing by Enviro-Chem used 500 ml of sample in a volume of approximately 170 cubic inches of steel slag. Flow rates for testing were approximately 0.15 gpm. Ideal residence time to achieve pH values between 6.5 and 9 as required by the Discharge Permit, was from 30 to 60 minutes. Longer residence times increased pH beyond the upper allowable limit of 9.0. To determine an appropriate volume for steel slag filter design we calculated the following:

Design flow rate/lab flow rate = scaling factor Where: Lab flow rate = 0.15 gpm
Design flow rate = 5 gpm

Scaling factor = 33

Required volume for filter = lab volume x scaling factor = 33 x 170 cubic inches = 5667 cu. in.

Converting cu. in to cu. ft. = 5667/1728 = 3.27 cu. ft., there are 7.481 gallons/cu. ft., so a 30-gallon container filled with steel slag would provide approximately 4 cubic feet of volume or one pass through the material for neutralization. To be conservative, we provided an outlet 6 inches below the top of the 30-gallon drum to prevent overflow which would provide approximately 25 gallons or 3.3 cubic feet of slag which would equal one (1) pass through the material. The outlet is similar to the design in Ziemkiewicz' study and allows precipitate to be conveyed to a downstream basin for settling and disposal.

2.5 Steel Slag Filter Design

As described in the options analysis in Section 2.1 in an inert 30-gallon HDPE transport drum and back up for a second pass to a 2-inch discharge outlet to either (a) a second slag filter if pH readings required it or (b) directly to a Smart Trench® HDPE settling basin prior to discharge to Deadman Gulch as before. The HDPE settling basin would have bulkheads at both ends to allow precipitate to settle out for cleaning. Based on proposed field pilot testing with an actual filter section, several filters could be placed in series to achieve desired water quality results as achieved in the bench testing. A slag filter could be maintained on stand-by at the mine site for rapid insertion into the 36-inch diameter corrugated metal pipe (CMP) filter housing. The "used" slag filter material could be laid out, air dried and re-used as determined by the mine operator.

As detailed in the Enviro-Chem bench testing study, the proposed slag material is from Harsco in Pueblo, Colorado and is sold as "r-slag", this steel slag material has been crushed and screened to provided slag that is from 3/8-inch to1/2-inch in nominal size. As noted in the references cited above and substantiated by Enviro-Chem' s testing, pulverized slag clogs too quickly and rapidly produces pH values that are higher than 9 and therefore unacceptable. Larger slag has less surface area and requires longer detention times.

Material specifications for all proposed equipment and materials for the proposed improvements are presented in Appendix E. of this report.

2.6 Treatment Process

The description of proposed treatment process using the steel slag filters is:

Groundwater day-lighting from the level 6 portal:

1. The water is captured in a Dura® trench drain at the mouth of the portal and conveyed through a 2-inch PVC pipe to the in-ground slag filter.

2. The water is distributed vertically into the slag using an 18-inch diameter circular manifold made of 2-inch diameter perforated HDPE or polyethylene piping attached to the 2-inch PVC inlet pipe. This allows the water to be evenly distributed to the slag to prevent short circuiting of the filter media.

3. Treated effluent passes vertically downward through the material and eventually fills the HDPE drum to the outlet level where it exits the drum and flows either to a second filter arrangement or directly to the settlement basin.

4. From the settlement basin, treated effluent is conveyed underground through a 2-inch PVC to the existing upper sump with a 6-inch distribution pipe to be conveyed to the surface of Deadman Gulch. There it will flow downslope over the existing limestone boulders to the lower sump where it will mix with treated effluent and distribution via the existing 0.5-foot H-flume back into Deadman Gulch.

Sheet C-2 of the attached design plans provides hydraulic plan and profiles of this process description.

Groundwater day-lighting near the waste rock pile beneath the level 6 pad:

1. The small seep will be intercepted by the lower sump, treated and allowed to flow out of the H-flume after mixing with any seasonally available Deadman Gulch flow as well as the treated effluent from the upper sump.

2. The water will be intercepted by a total of four 4-foot sections of Dura® drain and conveyed to a central Dura® catch basin. That catch basin will be tied in by a 3-inch PVC outlet pipe to a 4-inch perforated SDR 35 PVC manifold for even distribution into the slag contained in the sump. We estimate a total of 6 cubic yards of r-slag can be accommodated in the lower slump for treatment. The sump will continue to have an EPDM liner upstream of the concrete headwalls currently installed in this location.

3. Sampling and monitoring of the treated effluent will continue to be done at the outlet of the H-flume. We propose to install an InSitu Aqua Troll® 600 and Level Troll® 500 at this location to monitoring flows, water elevation and water quality parameters as outlined in the Section 3.0 below.

A detail of the proposed lower sump improvements is presented on Sheet C-3 of the design plans in Appendix F.

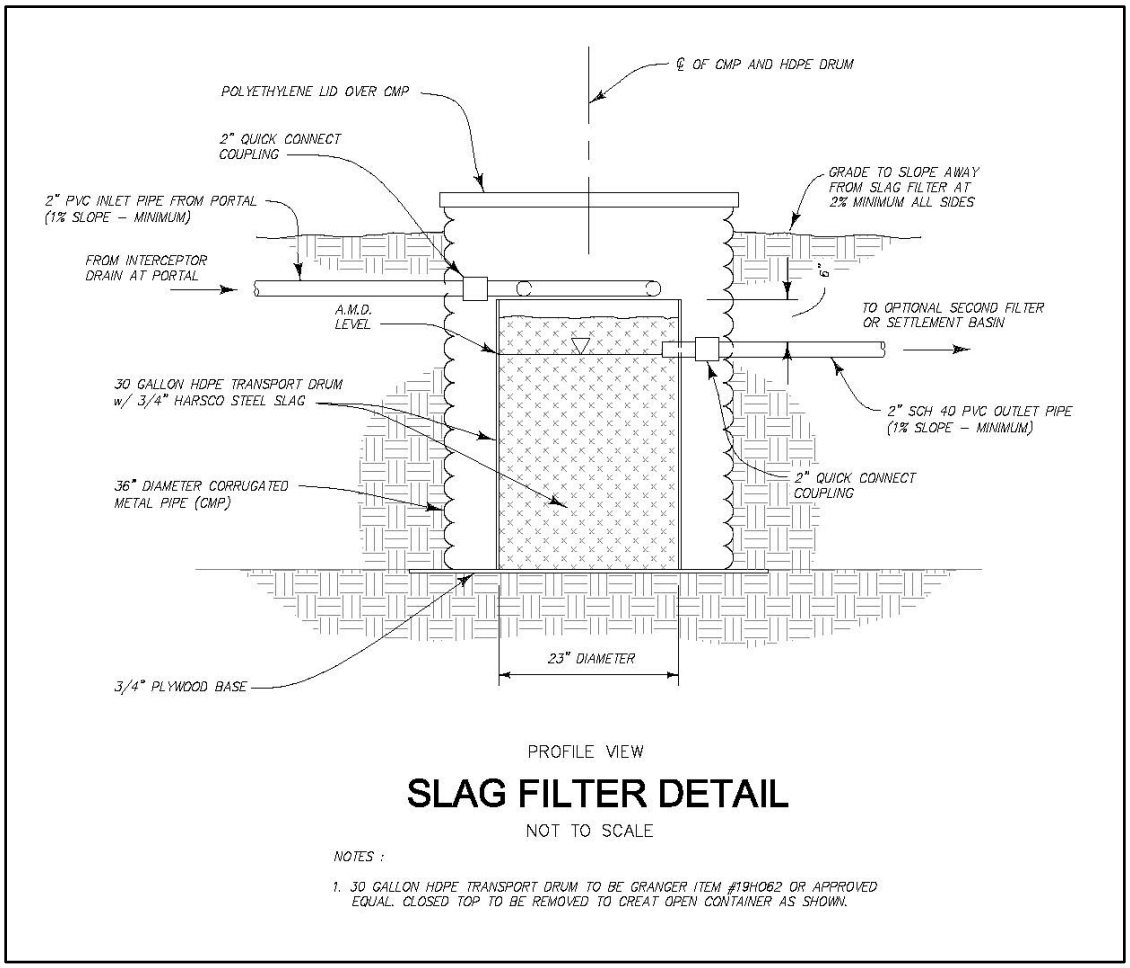


Figure 4**.** Schematic detail of proposed slag filter. Additional details are provided in Appendix F.

3.0 SAMPLING AND MONITORING

In order to achieve compliance with the monitoring and sampling required in the mine's discharge permit, we propose to install water monitoring devices from InSitu at the current lower sump monitoring location. Those instruments are the:

- AquaTroll® 600 Multiparameter Sonde and
- Level Troll® 500 Data Logger

The Aqua Troll will allow the mine owner/operator to continuously monitor and record the following parameters:

- pH
- Temperature
- Conductivity
- TSS
- TDS
- Salinity
- Ammonia
- Nitrate
- Chloride

The purpose of installing the Level Troll is to monitor and record water levels and flows to the accuracy required by the discharge permit. Data from both devices can be accessed via telemetry to cell phone or PC and will be used in completing the Discharge Monitoring reports

(DMR's) required as a condition of the permit. Details of the InSitu instruments are provided in Appendix E.

4.0 FIELD PILOT STUDY

Due to the challenges of translating bench test results to field conditions and due to a lack of practical field studies using steel slag in similar proposed filter system, we recommend that the operators of the Golden Wonder Mine conduct a field pilot study from of May to October 2017 to analyze treatment results and determine the optimum operating process for effective treatment that meets the requirements of the Discharge Permit.

5.0 CONCLUSIONS AND RECOMMENDATIONS

Based on documented success using steel slag to increase pH and precipitate metals, we recommend a field pilot study at the Golden Wonder Mine to determine the optimum slag filter configuration to achieve effluent compliance required in the Discharge Permit. The benefits of treating slag at the Level 6 pad and upper sump allows for treated water to continuously mix with the lower sump to flush and dilute the water being treated at that site. This should allow the large slag filter at the lower sump to remain effective for a long time to provide passive treatment. Deadman Gulch generally only flows from Mid-April to Early July depending on the snow pack and runoff. Additionally it flows during monsoonal storm events in the typical July to September storm season, but cannot be depended on to provide dilution, mixing and flushing that can be provided by treated effluent conveyed from the upper sump on the Level 6 pad.

6.0 CERTIFICATION

I, Daniel C. Quigley, a duly registered professional engineer in the State of Colorado, (registration #38334), have prepared this report, related documents, and supervised the preparation of the drawings enclosed. The information included is, to the best of my knowledge, accurate and conforming to accepted engineering practices for the preparation of design reports.

May 10, 2017

Daniel C. Quigley, PE, PG
Project Engineer

7.0. REFERENCES

Leite, Camila Marcon de Carvalho; Cardoso, Luisa Poyares and Mello, Jaime Wilson Vargas de, Use of Steel Slag to Neutralize Acid mine drainage (AMD) in Sulfidic Material from a Uranium Mine. *Rev. Bras. Ciênc. Solo* [online]. 2013, vol.37, n.3 [cited 2017-05-07], pp.804-811

Skousen, Jefferey, G., Sextone, Alan, and Ziemkiewiecz, Paul, F., Acid Mine Drainage, Control and Treatment, from Reclamation of Drastically Disturbed Lands, Chapter 6, American Society of Agronomy and American Society for Surface Mining and Reclamation, 2000

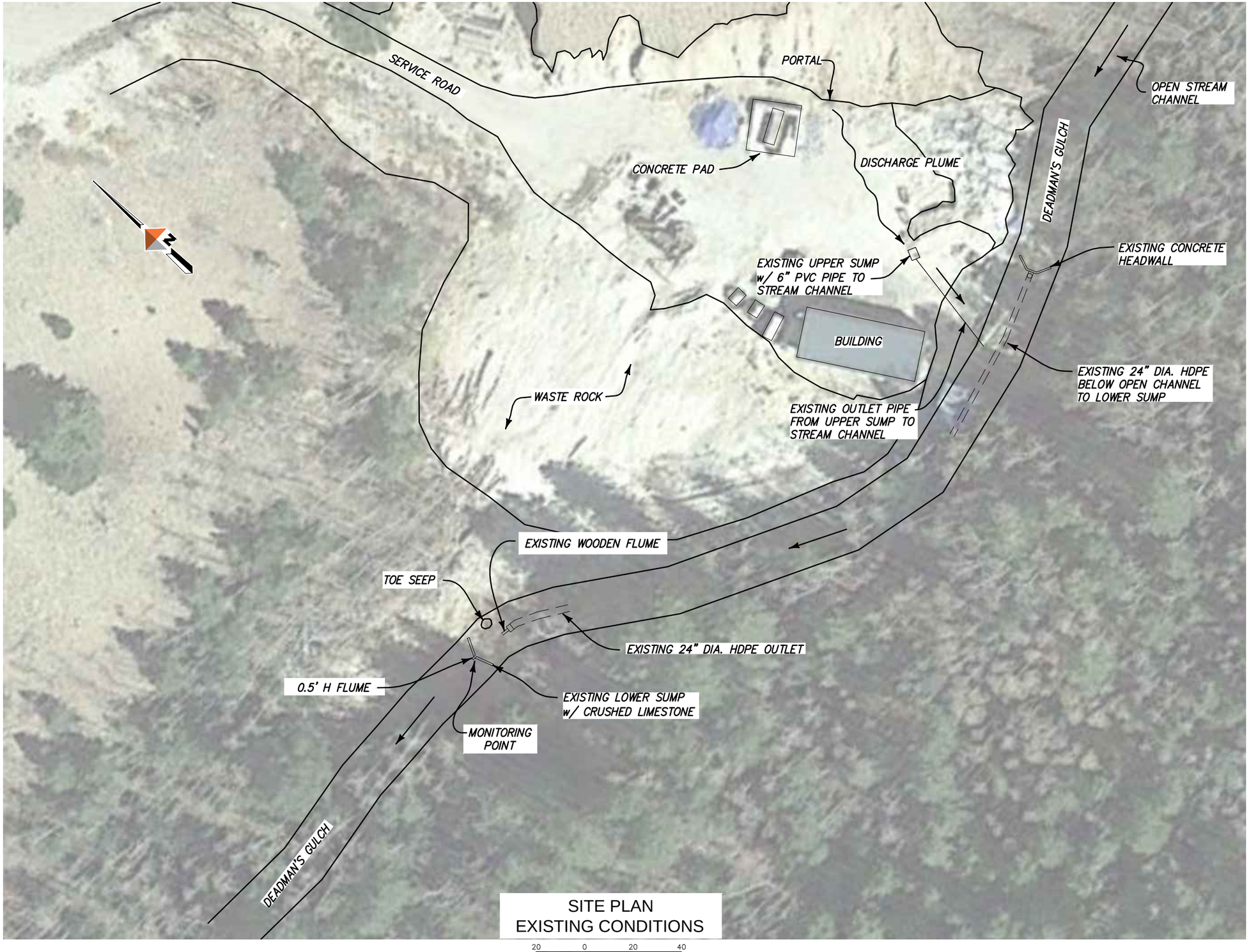
Ziemkiewicz, Paul, F. and Skousen, Jeffery, G., The Use of Steel Slag in Acid Mine Drainage Treatment and Control, proceedings of the American Society for Surface Mining and Reclamation, 1999, pp. 651-656

TIMS Steel Slag - http://www.tmsinternational.com/slag-aggregates.cfm

Harsco Metals and Materials - http://www.harscocrushedrock.com/materials/limestone-gravel-alternative.php

APPENDIX A

EXISTING CONDITIONS EXHIBIT



SITE PLAN
EXISTING CONDITIONS

20 0 20 40
SCALE IN FEET

REVISIONS			
REV	DATE	DESCRIPTION	BY

DOWL
WWW.DOWL.COM
222 South Park Avenue
Montrose, Colorado 81401
970-249-6828

GOLDEN WONDER MINE
SITE PLAN
EXISTING CONDITIONS

PROJECT 7131.74637.01
DATE 5/10/2017

SHEET
Exhibit 1
OF XX

APPENDIX B

CDPHE DISCHARGE PERMIT NO. CO-048119

AUTHORIZATION TO DISCHARGE UNDER THE

COLORADO DISCHARGE PERMIT SYSTEM

In compliance with the provisions of the Colorado Water Quality Control Act, (25-8-101 et seq., CRS, 1973 as amended), for both discharges to surface and ground waters, and the Federal Water Pollution Control Act, as amended (33 U.S.C. 1251 et seq.; the "Act"), for discharges to surface waters only, the

LKA INTERNATIONAL, LLC

is authorized to discharge from the Golden Wonder Mine located at S10, T43N, R004W, QTR NE; **Deadman Gulch Road, Lake City, CO 81235; 38° 0' 12.13" North Latitude, 107° 16' 59.77" West Longitude**

to **Deadman Gulch**

in accordance with effluent limitations, monitoring requirements and other conditions set forth in Parts I and II hereof. All discharges authorized herein shall be consistent with the terms and conditions of this permit.

The applicant may demand an adjudicatory hearing within thirty (30) days of the date of issuance of the final permit determination, per the Colorado Discharge Permit System Regulations, 61.7(1). Should the applicant choose to contest any of the effluent limitations, monitoring requirements or other conditions contained herein, the applicant must comply with Section 24-4-104 CRS and the Colorado Discharge Permit System Regulations. Failure to contest any such effluent limitation, monitoring requirement, or other condition, constitutes consent to the condition by the Applicant.

This permit and the authorization to discharge shall expire at midnight, **January 31, 2015**

Issued and Signed this 29th day of December, 2009

COLORADO DEPARTMENT OF PUBLIC HEALTH AND ENVIRONMENT

Andrew Neuhart for
Janet Kieler, Permits Section Manager
Water Quality Control Division

ISSUED AND SIGNED: DECEMBER 29, 2009

EFFECTIVE: FEBRUARY 1, 2010

TABLE OF CONTENTS

PART I

A. EFFLUENT LIMITATIONS AND MONITORING REQUIREMENTS

1. Effluent Limitations

Beginning no later than the effective date of this permit and lasting through the expiration date, the permittee is authorized to discharge from outfall: 001A, after treatment and prior to discharge into Deadman Gulch.

In accordance with the Water Quality Control Commission Regulations for Effluent Limitations, Section 62.4, and the Colorado Discharge Permit System Regulations, Section 61.8(2), 5 C.C.R. 1002-61, the permitted discharge shall not contain effluent parameter concentrations which exceed the following limitations specified below or exceed the specified flow limitation.

2. Monitoring Frequency and Sample Type

In order to obtain an indication of the probable compliance or noncompliance with the effluent limitations specified in Part I.A, the permittee shall monitor all effluent parameters at the following frequencies. Such monitoring will begin immediately and last for the life of the permit unless otherwise noted. The results of such monitoring shall be reported on the Discharge Monitoring Report form (See Part I.D.)

Self-monitoring sampling by the permittee for compliance with the monitoring requirements specified above shall be performed at the following location: **001A, after treatment and prior to discharge into Deadman Gulch, at 38° 0' 12.13" North Latitude, 107° 16' 59.77" West Longitude.**

If the permittee, using an approved analytical method, monitors any parameter more frequently than required by this permit, then the results of such monitoring shall be included in the calculation and reporting of the values required in the Discharge Monitoring Report Form (DMRs) or other forms as required by the Division. Such increased frequency shall also be indicated.

Oil and Grease Monitoring: For every outfall with oil and grease monitoring, in the event an oil sheen or floating oil is observed, a grab sample shall be collected, analyzed, and reported on the appropriate DMR. In addition, corrective action shall be taken immediately to mitigate the discharge of oil and grease. A description of the corrective action taken should be included with the DMR.

Outfall 001A

Effluent Parameter	Effluent Limitations Maximum Concentrations				Monitoring Requirements	
	30-Day Average *	7-Day Average *	Daily Maximum *	2-Year Average *	Frequency *	Sample Type *
Effluent Flow (MGD)	0.16		Report		Continuous	Recorder
pH (su)			6.5-9		Daily	Grab
TSS (mg/l)	20		30		5 Days/Week	Composite
Oil and Grease (mg/l)			10		Daily	Visual
TDS (mg/l)	Report		Report		Quarterly	Composite
Al, TR (µg/l)	Report		750	113	2 Days/Week	Composite
As, TR (µg/l)	100		Report	15	2 Days/Week	Composite
Cd, Total (ug/l)	50		100		2 Days/Week	Composite
Cd, PD (µg/l)	0.32		1.2	0.05	2 Days/Week	Composite
Cr, TR (µg/l)	Report		Report	Report	2 Days/Week	Composite
Cr+ 3, TR (µg/l)	Report		Report	Report	2 Days/Week	Composite
Cu, Total (ug/l)	150		300		2 Days/Week	Composite
Cu, PD (µg/l)	6.6		9.6	1	2 Days/Week	Composite
Fe, TR (µg/l)	1,000		Report	100	2 Days/Week	Composite
Pb, Total (ug/l)	300		600		2 Days/Week	Composite
Pb, PD (µg/l)	1.7		44	0.3	2 Days/Week	Composite
Mn, PD (µg/l)	1,465		2,651	220	2 Days/Week	Composite
Hg, Tot (µg/l)	1		2		2 Days/Week	Composite
Ni, PD (µg/l)	38		346	5.7	2 Days/Week	Composite
Se, PD (µg/l)	4.6		18	0.7	2 Days/Week	Composite
Ag, PD (µg/l)	0.04		1.1	0.006	2 Days/Week	Composite
Zn, Total (ug/l)	750		1500		2 Days/Week	Composite
Zn, PD (µg/l)	47		106	7.1	2 Days/Week	Composite
Sulfide (mg/l)	Report			Report	2 Days/Week	Composite
WET, chronic						
Pimephales Lethality			Stat Diff & IC25 ≥ IWC		Quarterly	3 Composites / Test
Ceriodaphnia Lethality					Quarterly	3 Composites / Test
Pimephales Toxicity			Report Stat Diff & IC25		Quarterly	3 Composites / Test
Ceriodaphnia Toxicity					Quarterly	3 Composites / Test

3. Salinity Parameters

In order to obtain an indication of the quantity of Salinity, measured as total dissolved solids (TDS), being discharged from the site the permittee shall monitor the wastewater effluent. Self-monitoring samples taken in compliance with the monitoring requirements specified below shall be taken at those locations listed in Part I.A.2.

B. TERMS AND CONDITIONS

1. Facilities Operation and Maintenance

The permittee shall at all times properly operate and maintain all facilities and systems of treatment and control (and related appurtenances) which are installed or used by the permittee as necessary to achieve compliance with the conditions of this permit. Proper operation and maintenance also includes adequate laboratory controls and appropriate quality assurance procedures. This provision requires the operation of back-up or auxiliary facilities or similar systems when installed by the permittee only when necessary to achieve compliance with the conditions of the permit. However, the permittee shall operate, at a minimum, one complete set of each main line unit treatment process whether or not this process is needed to achieve permit effluent compliance. Any sludge produced at the wastewater treatment facility shall be disposed of in accordance with State and Federal guidelines and regulations.

2. **Chronic WET Testing-Outfall(s): 001A**

a. Testing and Reporting Requirements

Tests shall be done at the frequency listed in Part I.A.2. Test results shall be reported along with the Discharge Monitoring Report (DMR) submitted for the reporting period during which the sample was taken. (i.e., WET testing results for the first calendar quarter ending March 31 shall be reported with the DMR due April 28.) The results shall be submitted on the Chronic Toxicity Test report form, available from the Division. Copies of these reports are to be submitted to both the Division and EPA along with the DMR.

The permittee shall conduct each chronic WET test in general accordance with methods described in Short Term Methods for Estimating the Chronic Toxicity of Effluents and Receiving Waters to Freshwater Organisms, EPA/600/4-89/001 or the most current edition, except as modified by the most current Division guidance document entitled Guidelines for Conducting Whole Effluent Toxicity Tests. The permittee shall conduct such tests using Ceriodaphnia dubia and fathead minnows.

b. Failure of Test and Division Notification

A chronic WET test is failed whenever there is a statistically significant difference in lethality between the control and any effluent concentration less than or equal to the instream waste concentration (IWC). The IWC for this permit has been determined to be **100**. The permittee must provide written notification of the failure of a WET test to the Division, along with a statement as to whether a Preliminary Toxicity Investigation (PTI)/Toxicity Identification Evaluation (TIE) or accelerated testing is being performed. **Notification must be received by the Division within 21 calendar days of the demonstration of chronic WET in the routine required test.** Demonstration for the purposes of Parts I.B.3.b., c., d., e. and g. means no later than the last day of the laboratory test.

c. Automatic Compliance Schedule Upon Failure of Test

If a routine chronic WET test is failed, regardless of whether the limit is in effect, the following automatic compliance schedule shall apply. As part of this, the permittee shall either.

i. Proceed to conduct the PTI/TIE investigation as described in Part I.B.3.d., or
ii. Conduct accelerated testing using the single species found to be more sensitive.

If accelerated testing is being performed, the permittee shall provide written notification of the results within 14 calendar days of completion of the Pattern of Toxicity/No Toxicity demonstration. Testing will be at least once every two weeks for up to five tests until; 1) two consecutive tests fail or three of five tests fail, in which case a pattern of toxicity has been demonstrated or 2) two consecutive tests pass or three of five tests pass, in which case no pattern of toxicity has been found. If no pattern of toxicity is found the toxicity episode is considered to be ended and routine testing is to resume. If a pattern of toxicity is found, a PTI/TIE investigation is to be performed. If a pattern of toxicity is not demonstrated but a significant level of erratic toxicity is found, the Division may require an increased frequency of routine monitoring or some other modified approach.

d. PTI/TIE

The results of the PTI/TIE investigation are to be received by the Divison within 120 days of the demonstration of chronic WET in the routine test, as defined above, or if accelerated testing is performed, the date the pattern of toxicity is demonstrated. A status report is to be provided to the Division at the 30, 60, and 90 day points of the PTI/TIE investigation. The Division may extend the time frame for investigation where reasonable justification exists. A request for an extension must be made in writing and received prior to the 120 day deadline. Such request must include a justification and supporting data for such an extension.

The permittee may use the time for investigation to conduct a PTI or move directly into the TIE. A PTI consists of a brief search for possible sources of WET, which might reveal causes of such toxicity and appropriate corrective actions more simply and cost effectively than a formal TIE. If the PTI allows resolutino of the WET incident, the TIE need not necessarily be conducted. If, however, WET is not identified or resolved during the PTI, the TIE must be conducted within the allowed 120 day time frame.

Any permittee that is required to conduct a PTI/TIE investigation shall do so in conformance with the procedures identified in the following documents, or as subsequently updated: 1) Toxicity Identification Evaluation: Characterization of Chronically Toxic Effluents, Phase I, EPA/600/6-91/005F May 92, 2) Methods for Aquatic Toxicity Identification Evaluations, Phase I Toxicity Characterization Procedures, EPA/600/6-91/003 Feb. 91 and 3) Methods for Aquatic Toxicity Identification Evaluations, Phase II Toxicity Identification Procedures, EPA/600/3-88/035Feb. 1989.

A fourth document in this series is Methods for Aquatic Toxicity Identification Evaluations, Phase III Toxicity Confirmation Procedures, EPA/600/3-88/036 Feb. 1989. As indicated by the title, this procedure is intended to confirm that the suspected toxicant is truly the toxicant. This investigation is optional.

Within 90 days of the determination of the toxicant or no later than 210 days after demonstration of toxicity, whichever is sooner, a control program is to be developed and received by the Division. The program shall set down a method and procedure for elimination of the toxicity to acceptable levels.

e. Request For Relief

The permittee may request relief from further investigation and testing where the toxicant has not been determined and suitable treatment does not appear possible. In requesting such relief, the permittee shall submit material sufficient to establish the following:

i. It has complied with terms and conditions of the permit compliance schedule for the PTI/TIE investigation and other appropriate conditions as may have been required by the WQCD;

ii. During the period of the toxicity incident it has been in compliance with all other permit conditions, including, in the case of a POTW, pretreatment requirements;

iii. During the period of the toxicity incident it has properly maintained and operated all facilities and systems of treatment and control; and

iv. Despite the circumstances described in paragraphs (i) and (iii) above, the source and/or cause of toxicity could not be located or resolved.

3. Stormwater Requirements

Stormwater Evaluation: Stormwater associated with industrial activities from metal mining facilities is required to be covered by a Colorado Discharge Permit System (CDPS) permit in order to be discharged to Waters of the State. Division records indicate that L K A International, Inc applied for and obtained coverage under a General Stormwater Discharge Permit, certification number COR-040226 for the Golden Wonder Mine. Stormwater permitting issues for this facility will be handled separately by the Division's Stormwater Unit.

C. DEFINITIONS OF TERMS

1. Antidegradation limits apply as the average of all data collected for months in that group during a rolling 24-month period. These limits become effective after data has been collected for all months in the group during the 24 months following permit issuance. Where antidegradation groups are not indicated, data from all months will be utilized to determine the reported value and the limit will become effective in the 24th month in which the permit is effective.

2. "Chronic lethality" occurs when a statistically significant difference, at the 95% confidence level, occurs in the chronic test between the mortality of the test species in **100** % effluent (the chronic IWC = 100%) and the control.

3. "Composite" sample is a minimum of four (4) grab samples collected at equally spaced two (2) hour intervals and proportioned according to flow.

4. "Continuous" measurement, is a measurement obtained from an automatic recording device which continually measures provides measurements.

5. "Daily Maximum limitation" for all parameters except temperature, means the limitation for this parameter shall be applied as an instantaneous maximum (or, for pH or DO, instantaneous minimum) value. The instantaneous value is defined as the analytical result of any individual sample. DMRs shall include the maximum (and/or minimum) of all instantaneous values within the calendar month. Any instantaneous value beyond the noted daily maximum limitation for the indicated parameter shall be considered a violation of this permit.

6. "Dissolved (D) metals fraction" is defined in the Basic Standards and Methodologies for Surface Water 1002-31, as that portion of a water and suspended sediment sample which passed through a 0.40 or 0.45 UM (micron) membrane filter. Determinations of "dissolved" constituents are made using the filtrate. This may include some very small (colloidal) suspended particles which passed through the membrane filter as well as the amount of substance present in true chemical solution.

7. "Grab" sample, is a single "dip and take" sample so as to be representative of the parameter being monitored.

8. "In-situ" measurement is defined as a single reading, observation or measurement taken in the field at the point of discharge.

9. "Instantaneous" measurement is a single reading, observation, or measurement performed on site using existing monitoring facilities.

10. "Potentially dissolved (PD) metals fraction" is defined in the Basic Standards and Methodologies for Surface Water 1002-31, as that portion of a constituent measured from the filtrate of a water and suspended sediment sample that was first treated with nitric acid to a pH of 2 or less and let stand for 8 to 96 hours prior to sample filtration using a 0.40 or 0.45-UM (micron) membrane filter. Note the "potentially dissolved" method cannot be used where nitric acid will interfere with the analytical procedure used for the constituent measured.

11. "Quarterly measurement frequency" means samples may be collected at any time during the calendar quarter if a continual discharge occurs. If the discharge is intermittent, then samples shall be collected during the period that discharge occurs.

12. "Recorder" requires the continuous operation of a chart and/or totalizer (or drinking water rotor meters or pump hour meters where previously approved.)

13. "Seven (7) day average" means, with the exception of fecal coliform or *E. coli* bacteria (see geometric mean), the arithmetic mean of all samples collected in a seven (7) consecutive day period. When calculating the 7-day average, a value of zero should be used in place of any value that is less than the reporting limit. **If all values are less than the PQL, and the PQL is greater than the permit limit "BDL" should be reported. If all values are less than the PQL, and the PQL is less than or equal to the permit limit, "<x" should be reported, where "x" is the reporting limit. Otherwise, the calculated average shall be reported. Note that it does not matter if a calculated average is greater or less than the PQL, it must be reported as a value.** Such seven (7) day averages shall be calculated for all calendar weeks, which are defined as beginning on Sunday and ending on Saturday. If the calendar week overlaps two months (i.e. the Sunday is in one month and the Saturday in the following month), the seven (7) day average calculated for that calendar week shall be associated with the month that contains the Saturday. Samples may not be used for more than one (1) reporting period.

14. "Thirty (30) day average" means, except for fecal coliform or *E. coli* bacteria (see geometric mean), the arithmetic mean of all samples collected during a thirty (30) consecutive-day period. When calculating the 30-day average, a value of zero should be used in place of any value that is less than the PQL. **If all values are less than the PQL, and the PQL is greater than the permit limit "BDL" should be reported. If all values are less than the PQL, and the PQL is less than or equal to the permit limit, "<x" should be reported, where "x" is the reporting limit. Otherwise, the calculated average shall be reported. Note that it does not matter if a calculated average is greater or less than the PQL, it must be reported as a value.** The permittee shall report the appropriate mean of all self-monitoring sample data collected during the calendar month on the Discharge Monitoring Reports. Samples shall not be used for more than one (1) reporting period.

15. "Total Metals" means the concentration of metals determined on an unfiltered sample following vigorous digestion (Section 4.1.3), or the sum of the concentrations of metals in both the dissolved and suspended fractions, as described in Manual of Methods for Chemical Analysis of Water and Wastes, U.S. Environmental Protection Agency, March 1979, or its equivalent.

16. "Total Recoverable Metals" means that portion of a water and suspended sediment sample measured by the total recoverable analytical procedure described in Methods for Chemical Analysis of Water and Wastes, U.S. Environmental Protection Agency, March 1979 or its equivalent.

17. "Twenty four (24) hour composite" sample is a combination of at least eight (8) sample aliquots of at least 100 milliliters, collected at equally spaced intervals during the operating hours of a facility over a twenty-four (24) hour period. For volatile pollutants, aliquots must be combined in the laboratory immediately before analysis. The composite must be flow proportional; either the time interval between each aliquot or the volume of each aliquot must be proportional to either the wastewater or effluent flow at the time of sampling or the total wastewater or effluent flow since the collection of the previous aliquot. Aliquots may be collected manually or automatically.

18. "Twice Monthly" monitoring frequency means that two samples shall be collected each calendar month on separate weeks with at least one full week between the two sample dates. Also, there shall be at least one full week between the second sample of a month and the first sample of the following month.

19. "Visual" observation is observing the discharge to check for the presence of a visible sheen or floating oil.

20. "Water Quality Control Division" or "Division" means the state Water Quality Control Division as established in 25-8-101 et al.)

Additional relevant definitions are found in the Colorado Water Quality Control Act, CRS §§ 25-8-101 et seq., the Colorado Discharge Permit System Regulations, Regulation 61 (5 CCR 1002-61) and other applicable regulations.

D. GENERAL MONITORING, SAMPLING AND REPORTING REQUIREMENTS

1. Routine Reporting of Data

Reporting of the data gathered in compliance with Part I.B.1 shall be on a **monthly** basis. Reporting of all data gathered shall comply with the requirements of Part I.E. (General Requirements). Monitoring results shall be summarized for each calendar month and reported on Division approved discharge monitoring report (DMR) forms (EPA form 3320-1). One form shall be mailed to the Water Quality Control Division, as indicated below, so that the DMR is received no later than the 28th day of the following month (for example, the DMR for the first calendar quarter must be received by the Division by April 28th). If no discharge occurs during the reporting period, "No Discharge" shall be reported.

The original signed copy of each discharge monitoring report (DMR) shall be submitted to the Division at the following address:

Colorado Department of Public Health and Environment
Water Quality Control Division
WQCD-P-B2
4300 Cherry Creek Drive South
Denver, Colorado 80246-1530

The Discharge Monitoring Report forms shall be filled out accurately and completely in accordance with requirements of this permit and the instructions on the forms. They shall be signed by an authorized person as identified in Part I.E.6.

2. Representative Sampling

Samples and measurements taken as required herein shall be representative of the volume and nature of the monitored discharge. All samples shall be taken at the monitoring points specified in this permit and, unless otherwise specified, before the effluent joins or is diluted by any other wastestream, body of water, or substance. Monitoring points shall not be changed without notification to and approval by the Division.

3. Analytical and Sampling Methods for Monitoring

The permittee shall install, calibrate, use and maintain monitoring methods and equipment, including biological and indicated pollutant monitoring methods. All sampling shall be performed by the permittee according to specified methods in 40 C.F.R.

Part 136; methods approved by EPA pursuant to 40 C.F.R. Part 136; or methods approved by the Division, in the absence of a method specified in or approved pursuant to 40 C.F.R. Part 136.

If the permit contains a numeric effluent limit, the analytical method and PQL selected for a parameter shall be the one that can measure compliance with the numeric effluent limit. If all analytical methods and corresponding PQLs are greater than the numeric effluent limit, then the analytical method with the lowest PQL shall be used.

If the permit contains a monitoring or report only requirement, the analytical method chosen shall be one that can measure to the potential numeric effluent limit(s) (maximum allowable pollutant concentration as shown in the WQA or fact sheet). If all analytical methods and corresponding PQLs are greater than the potential numeric effluent limit (s), then the analytical method with the lowest PQL shall be used.

If the permit contains an interim effluent limitation (a limit is report until such time as a numeric effluent limit becomes effective), the analytical method chosen shall be one that can measure to the final numeric effluent limit. If all analytical methods and corresponding PQLs are greater than the final numeric effluent limit (s), then the analytical method with the lowest PQL shall be used.

For parameters such as TIN, the analytical methods chosen shall be those that can measure to the potential or final numeric effluent limit, based on the sum of the PQLs for nitrate, nitrite and ammonia.

When the analytical method which complies with the above requirements has a PQL greater than the permit limit, the permittee shall report "BDL" on the DMR. Such reports will not be considered as violations of the permit limit, as long as the lowest available PQL is used for the analysis. When the analytical method which complies with the above requirements has a PQL that is equal to or less than the permit limitation, "< X" (where X = the actual PQL achieved by the laboratory) shall be reported on the DMR. For parameters that have only a monitoring or report only limitation, "< X" (where X = the actual PQL achieved by the laboratory) shall be reported on the DMR.

The present lowest PQLs for specific parameters, as determined by the State Laboratory (November 2008) are provided below for reference. Note that these PQLs are not necessarily the PQLs required to be used in this permit, dependent upon the requirements laid out in bold above. For a listing of the PQLs for organic parameters, please refer to the Division's Practical Quantitation Limitation Guidance Document, July 2008. Future requirements for metals PQLs will be contained in the Division's Practical Quantitation Limitation Guidance Document for Metals.

Parameter	Practical Quantitation Limits,	Parameter	Practical Quantitation Limits, µg/l
Aluminum	50 µg/l	Manganese	2 µg/l
Ammonia	1 mg/l	Mercury	0.1 µg/l
Arsenic	1 µg/l	Mercury (low-level)	0.003 µg/l
Barium	5 µg/l	Nickel	50 µg/l
Beryllium	1 µg/l	N-Ammonia	50 µg/l
BOD / CBOD	1 mg/l	N Nitrate/Nitrite	0.5 mg/l
Boron	50 µg/l	N-Nitrate	50 µg/l
Cadmium	1 µg/l	N-Nitrite	10 µg/l
Calcium	20 µg/l	Total Nitrogen	0.5 mg/l
Chloride	2 mg/l	Phenols	100 µg/l
Chlorine	0.1 mg/l	Phosphorus	10 µg/l
Total Residual Chlorine		Radium 226	1 pCi/l
DPD colorimetric	0.10 mg/l	Radium 228	1 pCi/l
Amperometric titration	0.05 mg/l	Selenium	1 µg/l
Chromium	20 µg/l	Silver	0.5 µg/l
Chromium, Hexavalent	20 µg/l	Sodium	0.2 mg/l
Copper	5 µg/l	Sulfate	5 mg/l
Cyanide (Direct / Distilled)	10 µg/l	Sulfide	0.2 mg/l
Cyanide, WAD+A47	5 µg/l	Total Dissolved Solids	10 mg/l
Fluoride	0.1 mg/l	Total Suspended Solids	10 mg/l
Iron	10 µg/l	Thallium	1 µg/l
Lead	1 µg/l	Uranium	1 µg/l
Magnesium	20 µg/l	Zinc	10 µg/l

These limits apply to the total recoverable or the potentially dissolved fraction of metals.

For hexavalent chromium, samples must be unacidified so dissolved concentrations will be measured rather than potentially dissolved concentrations. The procedure for determining settleable solids is contained in 40 CFR 434.64. The practical quantitation limit for measuring settleable solids under this part shall be 0.4 ml/l.

In the calculation of average concentrations, those analytical results that are less than the practical quantitation limit shall be considered to be zero for calculation purposes. If all individual analytical results that would be used in the calculations are below the practical quantitation limit, then "less than x ", where x is the practical quantitation limit, shall be reported on the monthly DMR. Otherwise, report the calculated value.

4. **Records**

The permittee shall establish and maintain records. Those records shall include the following:

a. The date, type, exact location, and time of sampling or measurements;
b. The individual(s) who performed the sampling or measurements;
c. The date(s) the analyses were performed;
d. The individual(s) who performed the analyses;
e. The analytical techniques or methods used;
f. The results of such analyses; and
g. Any other observations which may result in an impact on the quality or quantity of the discharge as indicated in 40 CFR 122.44 (i)(1)(iii).

The permittee shall retain for a minimum of three (3) years records of all monitoring information, including all original strip chart recordings for continuous monitoring instrumentation, all calibration and maintenance records, copies of all reports required by this permit and records of all data used to complete the application for this permit. This period of retention shall be extended during the course of any unresolved litigation regarding the discharge of pollutants by the permittee or when requested by the Division or EPA.

5. **Flow Measuring Device**

If not already a part of the permitted facility, within ninety (90) days after the effective date of the permit, a flow measuring device shall be installed to give representative values of effluent quantities at the respective discharge points. Unless specifically exempted, or modified in Part I.E.5 of this permit, a flow measuring device will be applicable at all designated discharge points.

At the request of the Division, the permittee shall show proof of the accuracy of any flow-measuring device used in obtaining data submitted in the monitoring report. The flow-measuring device must indicate values within ten (10) percent of the actual flow being discharged from the facility.

6. **Signatory and Certification Requirements**

a. All reports and other information required by the Division, shall be signed and certified for accuracy by the permittee in accord with the following criteria:

i) In the case of corporations, by a responsible corporate officer. For purposes of this section, the responsible corporate officer is responsible for the overall operation of the facility from which the discharge described in the form originates;

ii) In the case of a partnership, by a general partner;

iii) In the case of a sole proprietorship, by the proprietor;

iv) In the case of a municipal, state, or other public facility, by either a principal executive officer, or ranking elected official. For purposes of this section, a principal executive officer has responsibility for the overall operation of the facility from which the discharge originates;

v) By a duly authorized representative of a person described above, only if:

1) The authorization is made in writing by a person described in i, ii, iii, or iv above;

2) The authorization specifies either an individual or a position having responsibility for the overall operation of the regulated facility or activity such as the position of plant manager, operator of a well or a well field, superintendent, position of equivalent responsibility, or an individual or position having overall responsibility for environmental matters for the company. (A duly authorized representative may thus be either a named individual or any individual occupying a named position); and,

3) The written authorization is submitted to the Division.

b. If an authorization as described in this section is no longer accurate because a different individual or position has responsibility for the overall operation of the facility, a new authorization satisfying the requirements of this section must be submitted to the Division prior to or together with any reports, information, or applications to be signed by an authorized representative.

The permittee, or the duly authorized representative shall make and sign the following certification on all such documents:

"I certify under penalty of law that this document and all attachments were prepared under my direction or supervision in accordance with a system designed to assure that qualified personnel properly gather and evaluate the information submitted. Based on my inquiry of the person or persons who manage the system, or those persons directly responsible for gathering the information, the information submitted is to the best of my knowledge and belief, true, accurate and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment for knowing violations."

PART II

A. NOTIFICATION REQUIREMENTS

1. Notification to Parties

All notification requirements under this section shall be directed as follows:

a. Oral Notifications, during normal business hours shall be to:

Water Quality Protection Section - Industrial Compliance Program
Water Quality Control Division
Telephone: (303) 692-3500

b. Written notification shall be to:

Water Quality Protection Section - Industrial Compliance Program
Water Quality Control Division
Colorado Department of Public Health and Environment
WQCD-WQP-B2
4300 Cherry Creek Drive South
Denver, CO 80246-1530

2. Change in Discharge

The permittee shall notify the Division, in writing, of any planned physical alterations or additions to the permitted facility. Notice is required only when:

a. The alteration or addition could significantly change the nature or increase the quantity of pollutants discharged, or;

b. The alteration or addition results in a significant change in the permittee's sludge use or disposal practices, and such alteration, addition, or change may justify the application of permit conditions that are different from or absent in the existing permit, including notification of additional use or disposal sites not reported pursuant to an approved land application plan.

The permittee shall give advance notice to the Division of any planned changes in the permitted facility or activity which may result in noncompliance with permit requirements.

Whenever notification of any planned physical alterations or additions to the permitted facility is required pursuant to this section, the permittee shall furnish the Division such plans and specifications which the Division deems reasonably necessary to evaluate the effect on the discharge, the stream, or ground water. If the Division finds that such new or altered discharge might be inconsistent with the conditions of the permit, the Division shall require a new or revised permit application and shall follow the procedures specified in Sections 61.5 through 61.6, and 61.15 of the Colorado Discharge Permit System Regulations.

3. Special Notifications - Definitions

a. Bypass: The intentional diversion of waste streams from any portion of a treatment facility.

b. Severe Property Damage: Substantial physical damage to property at the treatment facilities which causes them to become inoperable, or substantial and permanent loss of natural resources which can reasonably be expected to occur in the absence of a bypass. It does not mean economic loss caused by delays in production.

c. Upset: An exceptional incident in which there is unintentional and temporary noncompliance with permit effluent limitations because of factors beyond the reasonable control of the permittee. An upset does not include noncompliance to the extent caused by operational error, improperly designed treatment facilities, inadequate treatment facilities, lack of preventative maintenance, or careless or improper operation.

4. **Noncompliance Notification**

a. If, for any reason, the permittee does not comply with or will be unable to comply with any discharge limitations or standards specified in this permit, the permittee shall, at a minimum, provide the Division and EPA with the following information:

i) A description of the discharge and cause of noncompliance;

ii) The period of noncompliance, including exact dates and times and/or the anticipated time when the discharge will return to compliance; and

iii) Steps being taken to reduce, eliminate, and prevent recurrence of the noncomplying discharge.

b. The permittee shall report the following circumstances **orally within twenty-four (24) hours** from the time the permittee becomes aware of the circumstances, and shall mail to the Division a written report containing the information requested in Part II.A.4 (a) **within five (5) days** after becoming aware of the following circumstances:

i) Circumstances leading to any noncompliance which may endanger health or the environment regardless of the cause of the incident;

ii) Circumstances leading to any unanticipated bypass which exceeds any effluent limitations in the permit;

iii) Circumstances leading to any upset which causes an exceedance of any effluent limitation in the permit;

iv) Daily maximum violations for any of the pollutants limited by Part I.A of this permit and specified as requiring 24-hour notification. This includes any toxic pollutant or hazardous substance or any pollutant specifically identified as the method to control any toxic pollutant or hazardous substance.

c. The permittee shall report instances of non-compliance which are not required to be reported within 24-hours at the time Discharge Monitoring Reports are submitted. The reports shall contain the information listed in sub-paragraph (a) of this section.

5. **Other Notification Requirements**

Reports of compliance or noncompliance with, or any progress reports on, interim and final requirements contained in any compliance schedule in the permit shall be submitted no later than fourteen (14) days following each scheduled date, unless otherwise provided by the Division.

The permittee shall notify the Division, in writing, thirty (30) days in advance of a proposed transfer of permit as provided in Part II.B.3.

The permittee's notification of all anticipated noncompliance does not stay any permit condition.

All existing manufacturing, commercial, mining, and silvicultural dischargers must notify the Division as soon as they know or have reason to believe:

a. That any activity has occurred or will occur which would result in the discharge, on a routine or frequent basis, of any toxic pollutant which is not limited in the permit, if that discharge will exceed the highest of the following "notification levels":

i) One hundred micrograms per liter (100 µg/l);

ii) Two hundred micrograms per liter (200 µg/l) for acrolein and acrylonitrile; five hundred micrograms per liter (500 µg/l) for 2,4-dinitrophenol and 2-methyl-4,6-dinitrophenol; and one milligram per liter (1.0 mg/l) for antimony;

iii) Five (5) times the maximum concentration value reported for that pollutant in the permit application in accordance with Section 61.4(2)(g).

iv) The level established by the Division in accordance with 40 C.F.R. § 122.44(f).

b. That any activity has occurred or will occur which would result in any discharge, on a non-routine or infrequent basis, of a toxic pollutant which is not limited in the permit, if that discharge will exceed the highest of the following "notification levels":

i) Five hundred micrograms per liter (500 µg/l);

ii) One milligram per liter (1 mg/l) for antimony; and

iii) Ten (10) times the maximum concentration value reported for that pollutant in the permit application.

iv) The level established by the Division in accordance with 40 C.F.R. § 122.44(f).

6. Bypass Notification

If the permittee knows in advance of the need for a bypass, a notice shall be submitted, at least ten days before the date of the bypass, to the Division. The bypass shall be subject to Division approval and limitations imposed by the Division. Violations of requirements imposed by the Division will constitute a violation of this permit.

7. Upsets

a. Effect of an Upset

An upset constitutes an affirmative defense to an action brought for noncompliance with permit effluent limitations if the requirements of paragraph (b) of this section are met. No determination made during administrative review of claims that noncompliance was caused by upset, and before an action for noncompliance, is final administrative action subject to judicial review.

b. Conditions Necessary for a Demonstration of Upset

A permittee who wishes to establish the affirmative defense of upset shall demonstrate through properly signed contemporaneous operating logs, or other relevant evidence that:

i) An upset occurred and that the permittee can identify the specific cause(s) of the upset; and

ii) The permitted facility was at the time being properly operated and maintained; and

iii) The permittee submitted proper notice of the upset as required in Part II.A.4. of this permit (24-hour notice); and

iv) The permittee complied with any remedial measure necessary to minimize or prevent any discharge or sludge use or disposal in violation of this permit which has a reason able likelihood of adversely affecting human health or the environment.

In addition to the demonstration required above, a permittee who wishes to establish the affirmative defense of upset for a violation of effluent limitations based upon water quality standards shall also demonstrate through monitoring, modeling or other methods that the relevant standards were achieved in the receiving water.

c. Burden of Proof

In any enforcement proceeding the permittee seeking to establish the occurrence of an upset has the burden of proof.

8. Discharge Point

Any discharge to the waters of the State from a point source other than specifically authorized by this permit is prohibited.

9. Proper Operation and Maintenance

The permittee shall at all times properly operate and maintain all facilities and systems of treatment and control (and related appurtenances) which are installed or used by the permittee as necessary to achieve compliance with the conditions of this

permit. Proper operation and maintenance includes effective performance and adequate laboratory and process controls, including appropriate quality assurance procedures (40 CFR 122.41(e)). This provision requires the operation of back-up or auxiliary facilities or similar systems which are installed by the permittee only when necessary to achieve compliance with the conditions of the permit.

10. Minimization of Adverse Impact

The permittee shall take all reasonable steps to minimize or prevent any discharge of sludge use or disposal in violation of this permit which has a reasonable likelihood of adversely affecting human health or the environment. As necessary, accelerated or additional monitoring to determine the nature and impact of the noncomplying discharge is required.

11. Removed Substances

Solids, sludges, or other pollutants removed in the course of treatment or control of wastewaters shall be disposed in accordance with applicable state and federal regulations.

For all domestic wastewater treatment works, at industrial facilities, the permittee shall dispose of sludge in accordance with all State and Federal regulations.

12. Submission of Incorrect or Incomplete Information

Where the permittee failed to submit any relevant facts in a permit application, or submitted incorrect information in a permit application or report to the Division, the permittee shall promptly submit the relevant information which was not submitted or any additional information needed to correct any erroneous information previously submitted.

13. Bypass

a. Bypasses are prohibited and the Division may take enforcement action against the permittee for bypass, unless:

   i) The bypass is unavoidable to prevent loss of life, personal injury, or severe property damage;

   ii) There were no feasible alternatives to bypass such as the use of auxiliary treatment facilities, retention of untreated wastes, or maintenance during normal periods of equipment downtime. This condition is not satisfied if adequate back-up equipment should have been installed in the exercise of reasonable engineering judgment to prevent a bypass which occurred during normal periods of equipment downtime or preventive maintenance; and

   iii) Proper notices were submitted in compliance with Part II.A.4.

b. "Severe property damage" as used in this Subsection means substantial physical damage to the treatment facilities which causes them to become inoperable, or substantial and permanent loss of natural resources which can reasonably be expected to occur in the absence of a bypass. Severe property damage does not mean economic loss caused by delays in production.

c. The permittee may allow a bypass to occur which does not cause effluent limitations to be exceeded, but only if it also is for essential maintenance or to assure optimal operation. These bypasses are not subject to the provisions of paragraph (a) above.

d. The Division may approve an anticipated bypass, after considering adverse effects, if the Division determines that the bypass will meet the conditions specified in paragraph (a) above.

14. Reduction, Loss, or Failure of Treatment Facility

The permittee has the duty to halt or reduce any activity if necessary to maintain compliance with the effluent limitations of the permit. Upon reduction, loss, or failure of the treatment facility, the permittee shall, to the extent necessary to maintain compliance with its permit, control production, control sources of wastewater, or all discharges, until the facility is restored or an alternative method of treatment is provided. This provision also applies to power failures, unless an alternative power source sufficient to operate the wastewater control facilities is provided.

It shall not be a defense for a permittee in an enforcement action that it would be necessary to halt or reduce the permitted activity in order to maintain compliance with the conditions of this permit.

B. RESPONSIBILITIES

1. Inspections and Right to Entry

The permittee shall allow the Division and/or the authorized representative, upon the presentation of credentials:

a. To enter upon the permittee's premises where a regulated facility or activity is located or in which any records are required to be kept under the terms and conditions of this permit;

b. At reasonable times to have access to and copy any records required to be kept under the terms and conditions of this permit and to inspect any monitoring equipment or monitoring method required in the permit; and

c. To enter upon the permittee's premises in a reasonable manner and at a reasonable time to inspect and/or investigate, any actual, suspected, or potential source of water pollution, or to ascertain compliance or non compliance with the Colorado Water Quality Control Act or any other applicable state or federal statute or regulation or any order promulgated by the Division. The investigation may include, but is not limited to, the following: sampling of any discharge and/or process waters, the taking of photographs, interviewing of any person having knowledge related to the discharge permit or alleged violation, access to any and all facilities or areas within the permittee's premises that may have any affect on the discharge, permit, or alleged violation. Such entry is also authorized for the purpose of inspecting and copying records required to be kept concerning any effluent source.

d. The permittee shall provide access to the Division to sample the discharge at a point after the final treatment process but prior to the discharge mixing with state waters upon presentation of proper credentials.

In the making of such inspections, investigations, and determinations, the Division, insofar as practicable, may designate as its authorized representatives any qualified personnel of the Department of Agriculture. The Division may also request assistance from any other state or local agency or institution.

2. Duty to Provide Information

The permittee shall furnish to the Division, within a reasonable time, any information which the Division may request to determine whether cause exists for modifying, revoking and reissuing, or terminating this permit, or to determine compliance with this permit. The permittee shall also furnish to the Division, upon request, copies of records required to be kept by this permit.

3. Transfer of Ownership or Control

a. Except as provided in paragraph b. of this section, a permit may be transferred by a permittee only if the permit has been modified or revoked and reissued as provided in Section 61.8(8) of the Colorado Discharge Permit System Regulations, to identify the new permittee and to incorporate such other requirements as may be necessary under the Federal Act.

b. A permit may be automatically transferred to a new permittee if:

i) The current permittee notifies the Division in writing 30 days in advance of the proposed transfer date; and

ii) The notice includes a written agreement between the existing and new permittee(s) containing a specific date for transfer of permit responsibility, coverage and liability between them; and

iii) The Division does not notify the existing permittee and the proposed new permittee of its intent to modify, or revoke and reissue the permit.

iv) Fee requirements of the Colorado Discharge Permit System Regulations, Section 61.15, have been met.

4. Availability of Reports

Except for data determined to be confidential under Section 308 of the Federal Clean Water Act and the Colorado Discharge Permit System Regulations 5 CCR 1002-61, Section 61.5(4), all reports prepared in accordance with the terms of this permit shall be available for public inspection at the offices of the Division and the Environmental Protection Agency.

The name and address of the permit applicant(s) and permittee(s), permit applications, permits and effluent data shall not be considered confidential. Knowingly making false statement on any such report may result in the imposition of criminal penalties as provided for in Section 309 of the Federal Clean Water Act, and Section 25-8-610 C.R.S.

5. Modification, Suspension, Revocation, or Termination of Permits By the Division

The filing of a request by the permittee for a permit modification, revocation and reissuance, termination or a notification of planned changes or anticipated noncompliance, does not stay any permit condition.

a. A permit may be modified, suspended, or terminated in whole or in part during its term for reasons determined by the Division including, but not limited to, the following:

   i) Violation of any terms or conditions of the permit;

   ii) Obtaining a permit by misrepresentation or failing to disclose any fact which is material to the granting or denial of a permit or to the establishment of terms or conditions of the permit; or

   iii) Materially false or inaccurate statements or information in the permit application or the permit.

   iv) A determination that the permitted activity endangers human health or the classified or existing uses of state waters and can only be regulated to acceptable levels by permit modifications or termination.

b. A permit may be modified in whole or in part for the following causes, provided that such modification complies with the provisions of Section 61.10 of the Colorado Discharge Permit System Regulations:

   i) There are material and substantial alterations or additions to the permitted facility or activity which occurred after permit issuance which justify the application of permit conditions that are different or absent in the existing permit.

   ii) The Division has received new information which was not available at the time of permit issuance (other than revised regulations, guidance, or test methods) and which would have justified the application of different permit conditions at the time of issuance. For permits issued to new sources or new dischargers, this cause includes information derived from effluent testing required under Section 61.4(7)(e) of the Colorado Discharge Permit System Regulations. This provision allows a modification of the permit to include conditions that are less stringent than the existing permit only to the extent allowed under Section 61.10 of the Colorado Discharge Permit System Regulations.

   iii) The standards or regulations on which the permit was based have been changed by promulgation of amended standards or regulations or by judicial decision after the permit was issued. Permits may be modified during their terms for this cause only as follows:

      (A) The permit condition requested to be modified was based on a promulgated effluent limitation guideline, EPA approved water quality standard, or an effluent limitation set forth in 5 CCR 1002-62, § 62 et seq.; and

      (B) EPA has revised, withdrawn, or modified that portion of the regulation or effluent limitation guideline on which the permit condition was based, or has approved a Commission action with respect to the water quality standard or effluent limitation on which the permit condition was based; and

      (C) The permittee requests modification after the notice of final action by which the EPA effluent limitation guideline, water quality standard, or effluent limitation is revised, withdrawn, or modified; or

      (D) For judicial decisions, a court of competent jurisdiction has remanded and stayed EPA promulgated regulations or effluent limitation guidelines, if the remand and stay concern that portion of the regulations or guidelines on

which the permit condition was based and a request is filed by the permittee in accordance with this Regulation, within ninety (90) days of judicial remand.

iv) The Division determines that good cause exists to modify a permit condition because of events over which the permittee has no control and for which there is no reasonable available remedy.

v) The permittee has received a variance.

vi) When required to incorporate applicable toxic effluent limitation or standards adopted pursuant to § 307(a) of the Federal act.

vii) When required by the reopener conditions in the permit.

viii) As necessary under 40 C.F.R. 403.8(e), to include a compliance schedule for the development of a pretreatment program.

ix) When the level of discharge of any pollutant which is not limited in the permit exceeds the level which can be achieved by the technology-based treatment requirements appropriate to the permittee under Section 61.8(2) of the Colorado Discharge Permit System Regulations.

x) To establish a pollutant notification level required in Section 61.8(5) of the Colorado Discharge Permit System Regulations.

xi) To correct technical mistakes, such as errors in calculation, or mistaken interpretations of law made in determining permit conditions, to the extent allowed in Section 61.10 of the Colorado State Discharge Permit System Regulations.

xii) When required by a permit condition to incorporate a land application plan for beneficial reuse of sewage sludge, to revise an existing land application plan, or to add a land application plan.

xiii) For any other cause provided in Section 61.10 of the Colorado Discharge Permit System Regulations.

c. At the request of a permittee, the Division may modify or terminate a permit and issue a new permit if the following conditions are met:

i) The Regional Administrator has been notified of the proposed modification or termination and does not object in writing within thirty (30) days of receipt of notification,

ii) The Division finds that the permittee has shown reasonable grounds consistent with the Federal and State statutes and regulations for such modifications or termination;

iii) Requirements of Section 61.15 of the Colorado Discharge Permit System Regulations have been met, and

iv) Requirements of public notice have been met.

d. Permit modification (except for minor modifications), termination or revocation and reissuance actions shall be subject to the requirements of Sections 61.5(2), 61.5(3), 61.6, 61.7 and 61.15 of the Colorado Discharge Permit System Regulations. The Division shall act on a permit modification request, other than minor modification requests, within 180 days of receipt thereof. Except for minor modifications, the terms of the existing permit govern and are enforceable until the newly issued permit is formally modified or revoked and reissued following public notice.

e. Upon consent by the permittee, the Division may make minor permit modifications without following the requirements of Sections 61.5(2), 61.5(3), 61.7, and 61.15 of the Colorado Discharge Permit System Regulations. Minor modifications to permits are limited to:

i) Correcting typographical errors; or

ii) Increasing the frequency of monitoring or reporting by the permittee; or

iii) Changing an interim date in a schedule of compliance, provided the new date of compliance is not more than 120 days after the date specific in the existing permit and does not interfere with attainment of the final compliance date requirement; or

iv) Allowing for a transfer in ownership or operational control of a facility where the Division determines that no other change in the permit is necessary, provided that a written agreement containing a specific date for transfer of permit responsibility, coverage and liability between the current and new permittees has been submitted to the Division; or

v) Changing the construction schedule for a discharger which is a new source, but no such change shall affect a discharger's obligation to have all pollution control equipment installed and in operation prior to discharge; or

vi) Deleting a point source outfall when the discharge from that outfall is terminated and does not result in discharge of pollutants from other outfalls except in accordance with permit limits.

f. When a permit is modified, only the conditions subject to modification are reopened. If a permit is revoked and reissued, the entire permit is reopened and subject to revision and the permit is reissued for a new term.

g. The filing of a request by the permittee for a permit modification, revocation and reissuance or termination does not stay any permit condition.

h. All permit modifications and reissuances are subject to the antibacksliding provisions set forth in 61.10(e) through (g).

6. **Oil and Hazardous Substance Liability**

Nothing in this permit shall be construed to preclude the institution of any legal action or relieve the permittee from any responsibilities, liabilities, or penalties to which the permittee is or may be subject to under Section 311 (Oil and Hazardous Substance Liability) of the Clean Water Act.

7. **State Laws**

Nothing in this permit shall be construed to preclude the institution of any legal action or relieve the permittee from any responsibilities, liabilities, or penalties established pursuant to any applicable State law or regulation under authority granted by Section 510 of the Clean Water Act. Nothing in this permit shall be construed to prevent or limit application of any emergency power of the division.

8. **Permit Violations**

Failure to comply with any terms and/or conditions of this permit shall be a violation of this permit. The discharge of any pollutant identified in this permit more frequently than or at a level in excess of that authorized shall constitute a violation of the permit. Except as provided in Part I.D and Part II.A or B, nothing in this permit shall be construed to relieve the permittee from civil or criminal penalties for noncompliance (40 CFR 122.41(a)(1)).

9. **Property Rights**

The issuance of this permit does not convey any property or water rights in either real or personal property, or stream flows, or any exclusive privileges, nor does it authorize any injury to private property or any invasion of personal rights, nor any infringement of Federal, State or local laws or regulations.

10. **Severability**

The provisions of this permit are severable. If any provisions of this permit, or the application of any provision of this permit to any circumstance, is held invalid, the application of such provision to other circumstances and the application of the remainder of this permit shall not be affected.

11. Renewal Application

If the permittee desires to continue to discharge, a permit renewal application shall be submitted at least one hundred eighty (180) days before this permit expires. If the permittee anticipates there will be no discharge after the expiration date of this permit, the Division should be promptly notified so that it can terminate the permit in accordance with Part II.B.5.

12. Confidentiality

Any information relating to any secret process, method of manufacture or production, or sales or marketing data which has been declared confidential by the permittee, and which may be acquired, ascertained, or discovered, whether in any sampling investigation, emergency investigation, or otherwise, shall not be publicly disclosed by any member, officer, or employee of the Commission or the Division, but shall be kept confidential. Any person seeking to invoke the protection of this Subsection (12) shall bear the burden of proving its applicability. This section shall never be interpreted as preventing full disclosure of effluent data.

13. Fees

The permittee is required to submit payment of an annual fee as set forth in the 2005 amendments to the Water Quality Control Act. Section 25-8-502 (1) (b), and the Colorado Discharge Permit System Regulations 5 CCR 1002-61, Section 61.15 as amended. Failure to submit the required fee when due and payable is a violation of the permit and will result in enforcement action pursuant to Section 25-8-601 et. seq., C.R.S. 1973 as amended.

14. Duration of Permit

The duration of a permit shall be for a fixed term and shall not exceed five (5) years. Filing of a timely and complete application shall cause the expired permit to continue in force to the effective date of the new permit. The permit's duration may be extended only through administrative extensions and not through interim modifications.

15. Section 307 Toxics

If a toxic effluent standard or prohibition, including any applicable schedule of compliance specified, is established by regulation pursuant to Section 307 of the Federal Act for a toxic pollutant which is present in the permittee's discharge and such standard or prohibition is more stringent than any limitation upon such pollutant in the discharge permit, the Division shall institute proceedings to modify or revoke and reissue the permit to conform to the toxic effluent standard or prohibition.

16. Effect of Permit Issuance

a. The issuance of a permit does not convey any property rights or any exclusive privilege.

b. The issuance of a permit does not authorize any injury to person or property or any invasion of personal rights, nor does it authorize the infringement of federal, state, or local laws or regulations.

c. Except for any toxic effluent standard or prohibition imposed under Section 307 of the Federal act or any standard for sewage sludge use or disposal under Section 405(d) of the Federal act, compliance with a permit during its term constitutes compliance, for purposes of enforcement, with Sections 301, 302, 306, 318, 403, and 405(a) and (b) of the Federal act. However, a permit may be modified, revoked and reissued, or terminated during its term for cause as set forth in Section 61.8(8) of the Colorado Discharge Permit System Regulations.

d. Compliance with a permit condition which implements a particular standard for sewage sludge use or disposal shall be an affirmative defense in any enforcement action brought for a violation of that standard for sewage sludge use or disposal.

APPENDIX C

FLOW RECORDS – BLACK CREEK HYDROLOGY

GOLDEN WONDER MINE
LOWER SUMP FLOWS

MONTH	SOLINST TRANSDUCER		MANUAL MEASUREMENT	
	AVERAGE FLOW (GPM)	PEAK DAY FLOW (GPM)	AVERAGE FLOW (GPM)	PEAK DAY FLOW (GPM)
2016				
MAY	22.85	47.44	-	-
JUNE	3.03	9.07	-	-
JULY	0.36	25.02	0.37	0.46
AUGUST	0.66	47.44	0.45	2.40
SEPTEMBER	0.52	11.22	0.15	0.19
OCTOBER	0.12	0.17	0.13	0.17
NOVEMBER	0.06	0.06	0.06	0.06
2017				
*MAY	-	-	11.98	11.98

*Single manual measurement taken 5/3/2017

Note: Flows represent total flow at the lower sump which includes seasonal Deadman Gulch flow as well as AMD. Manual measurement was time to fill a 1-gallon jug

GOLDEN WONDER MINE
LOWER SUMP FLOWS

15869.97	32944.22		
2103.272	6295.782		
248.743	17374.87	257.0858	318.0418
461.4621	32944.22	309.5061	1666.645
359.3704	7791.615	104.6958	133.5342
86.80444	115.7393	88.10651	115.7393
43.40222	43.40222	43.40222	43.40222

TRACOM INC.
770.664.6513 (V) 770.664.6565 (F)

Discharge Table For 0.5' H Flume

Document: H5-D-T Rev.: 0 Date: 4-6-00 By: Matt Kazmier

LEVEL		FLOW		
FEET	INCHES	CFS	GPM	MGD
0.01	0.12			
0.02	0.24	0.0004	0.1795	0.0003
0.03	0.36	0.0009	0.4039	0.0006
0.04	0.48	0.0016	0.7181	0.0010
0.05	0.60	0.0024	1.077	0.0016
0.06	0.72	0.0035	1.571	0.0023
0.07	0.84	0.0047	2.109	0.0030
0.08	0.96	0.0063	2.827	0.0041
0.09	1.08	0.0080	3.590	0.0052
0.10	1.20	0.0101	4.533	0.0065
0.11	1.32	0.0122	5.475	0.0079
0.12	1.44	0.0146	6.552	0.0094
0.13	1.56	0.0173	7.764	0.0112
0.14	1.68	0.0202	9.066	0.0131
0.15	1.80	0.0233	10.46	0.0151
0.16	1.92	0.0267	11.98	0.0173
0.17	2.04	0.0304	13.64	0.0196
0.18	2.16	0.0343	15.39	0.0222
0.19	2.28	0.0385	17.28	0.0249
0.20	2.40	0.0431	19.34	0.0279
0.21	2.52	0.0479	21.50	0.0310
0.22	2.64	0.0530	23.79	0.0343
0.23	2.76	0.0585	26.25	0.0378
0.24	2.88	0.0643	28.86	0.0416
0.25	3.00	0.0704	31.60	0.0455
0.26	3.12	0.0767	34.42	0.0496
0.27	3.24	0.0834	37.43	0.0539
0.28	3.36	0.0905	40.62	0.0585
0.29	3.48	0.0979	43.94	0.0633
0.30	3.60	0.1057	47.44	0.0683
0.31	3.72	0.1139	51.12	0.0736
0.32	3.84	0.1224	54.93	0.0791
0.33	3.96	0.1314	58.97	0.0849
0.34	4.08	0.1407	63.15	0.0909
0.35	4.20	0.1505	67.54	0.0973
0.36	4.32	0.1607	72.12	0.1039
0.37	4.44	0.1713	76.88	0.1107
0.38	4.56	0.1823	81.82	0.1178
0.39	4.68	0.1938	86.98	0.1253
0.40	4.80	0.2050	92.00	0.1325
0.41	4.92	0.2170	97.39	0.1402
0.42	5.04	0.2300	103.2	0.1486
0.43	5.16	0.2440	109.5	0.1577
0.44	5.28	0.2570	115.3	0.1661
0.45	5.40	0.2710	121.6	0.1751
0.46	5.52	0.2850	127.9	0.1842
0.47	5.64	0.3000	134.6	0.1939
0.48	5.76	0.3150	141.4	0.2036
0.49	5.88	0.3310	148.6	0.2139

Source: Field Manual for Research in Agricultural Hydrology, Handbook No. 224, United States Department of Agriculture, February, 1979, pp. 92.

APPENDIX D

STEEL SLAG STUDY – ENVIRO-CHEM ANALYTICAL, INC.

Enviro-Chem Analytical, Inc.
2493 Hwy 6&50, Unit 7
Grand Junction, CO 81505

To: LKA International
3724 47th St. CT
N.W.
Gig Harbor, WA 98335

Date: March 31, 2017
No: ECA/LKA 17-SLAG

STEEL SLAG STUDY

In October 2016, Enviro-Chem was retained by LKA Gold Incorporated (LKA) to do a comparative bench study of the effectiveness of three different Steel Slag products using Acid Mine Drainage (AMD for future reference) from LKA's Golden Wonder mine (Golden Wonder or Mine) to determine whether this might be an effective material to neutralize the acid nature of the mine discharge water.

Background Information on AMD water from the Golden Wonder Mine:

Due to the lack of mining currently taking place at the Golden Wonder Mine, a new situation arose in 2016, wherein, a measurable increase in discharge water, directly from the mine, occurred. In past years, the discharge was mainly from a relatively small seep located at the toe of the mine waste dump and water within the mine was being reused in mining operations and not discharged. This increase in AMD highlighted significant problems with the passive water treatment currently in place.

A limestone sump and weir had been created several years earlier and had proven effective in neutralizing the pH of the seep water, which was generated in smaller doses over the course of a year. With the increase in AMD water volume, this treatment methodology proved ineffective and other immediate solutions were sought.

Limestone poses a problem in this type of passive treatment due to several factors. Firstly, limestone requires a significantly long exposure time to be fully effective. It also is subject to significant coating, rendering the unreacted portions of the material to become encapsulated and thereby, unavailable for reaction with the AMD water.

Attempts were made to "regenerate" the limestone sump by agitating and turning the limestone material, however, this proved effective only in the short term. Due to the location of the mine and the lack of on-site personnel to continually monitor and "regenerate" the limestone, additional methods were sought.

To help achieve good pH control, soda ash was utilized on the AMD water where it exits the mine. This proved to be highly successful in raising the pH of the water and dropping the metals of interest out as a precipitate. This method, however, required on-going attention and was very

subjective. During times of storm water events, the flow rate of water increased significantly, and additional soda ash was required to maintain an acceptable treatment strategy. Again, this method proved to be less passive than the mine site requires and additional treatment methods were researched.

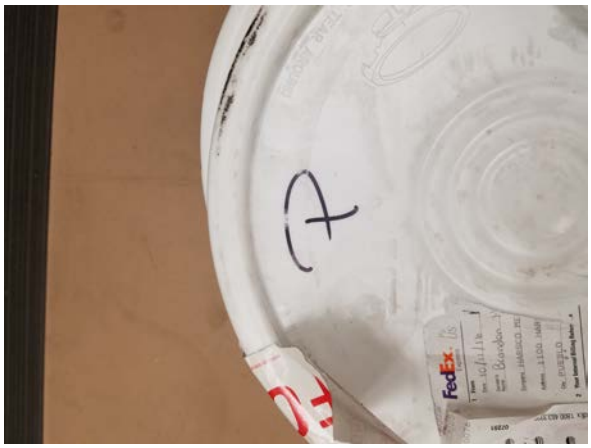
The use of Steel Slag was suggested by DOWL engineers who were retained by LKA to investigate possible solutions. After researching previous studies, Harsco Pueblo Slag Company was contacted by DOWL and three different materials were sent to the laboratory in November, 2016. Ten gallons of discharge directly from the mine were also obtained in October 2016 for use in the resulting study.

Initial lab testing was done on the procured mine water to set a baseline for the metal contamination present and to help validate whether or not the treatment materials were effective for this particular situation. The table below indicates the Total Metal concentrations that were identified in the Golden Wonder Discharge water – pre-treatment.

Table 1: Golden Wonder Discharge Water – Pre-Treatment, Oct. 2016

Parameter	Value, up/L
pH	2.68 s.u.
Aluminum	1350
Arsenic	48
Cadmium	16.7
Chromium	<10
Copper	478
Iron	11200
Lead	39
Manganese	583
Mercury	1.3
Nickel	230
Selenium	14
Silver	<10
Zinc	656

The three sizes of slag used in the bench study are identified as follows:



The is identified as the P-Slag, or pulverized. The slag was a powder with only a few particles >1/8" in diameter. Product did not float when water was added.

This is identified as the R-Slag. It contains particles that range between 1/8" to 1/2" in diameter.

The third and final material is identified as the B-Slag. This material is characterized by particles between 1" and 4" in diameter.

Initial lab testing was performed on each slag material with Mine water. 300 mL of AMD water was added to a 4" wide beaker containing 1" of each Slag material. Testing was done at 0, 1, 2, 3, 4, 5, 10, and 15 minutes with the following results. Increments were then increased to 30, 45 and finally 60 minutes' contact time between slag and water.

Table 2: Initial Slag Testing on Golden Wonder AMD Water

Time	P-Slag	R-Slag	B-Slag
0 minutes	2.68	2.68	2.68
1 minutes	2.89	2.72	2.69
2 minutes	3.12	2.86	2.71
3 minutes	3.55	2.99	2.76
4 minutes	4.23	3.06	2.98
5 minutes	5.75	3.30	3.11
10 minutes	7.23	4.30	3.30
15 minutes	9.12	5.30	4.40
30 minutes	10.20	7.02	4.80
45 minutes	11.70	7.66	5.41
60 minutes	11.73	7.78	7.07

At this point, the P-Slag was removed from the study do to the lack of control over the pH. The target pH for treatment is between 6 and 9, with an optimal target of 7.5. Given that within 10 minutes of contacting the P-Slag the pH was already nearing this value, and an additional fifteen minutes of contact time resulted in a pH that is too high for the discharge permit, this material is not appropriate for the passive system design being considered.

Next, a TCLP Metals test was run on both the R-Slag and the B-Slag material to ensure that the resulting leach water is suitable for discharge. The table below outlines the results of the TCLP Metals test. As can be seen, neither material contributed leachable metals that would result in a failed TCLP test.

Table 3: TCLP results of Slag Materials

TCLP Metals	R-Slag, mg/L	B-Slag, mg/L	TCLP Limits, mg/L
Arsenic	<0.005	<0.005	5.00
Barium	0.022	0.012	100.0
Cadmium	<0.005	<0.005	1.00
Chromium	<0.05	<0.05	5.00
Lead	0.067	0.043	5.00
Mercury	<0.000025	<0.000025	0.200
Selenium	0.026	0.017	1.00
Silver	<0.010	<0.010	5.00

Testing was then carried out on the R-Slag and the B-Slag as follows. 500 mL of Golden Wonder AMD water was used for each test and applied to a horizontal column of each slag material, 3" deep and 24" in length. No noticeable delay was observed in the ability of the water to move through the material. The total time required for the water to pass through the column of slag was less than 1 minute.

Table 4 details the resulting pH readings after the Mine water completed one pass through the column of material. These slag columns retained no standing water, but a constantly moving flow of water. One pass consists of 500 mL of water being passed through the column. Subsequent passes were carried out with the same water.

Table 4: Initial readings for 3" x 24" horizontal column, constant flow rate of 500 mL/< 1 minute.

# Passes	R-Slag, pH	B-Slag, pH
0	2.68	2.68
1	3.30	2.90
2	3.70	3.10
3	4.10	3.30
4	4.50	3.50
6	4.90	4.00
7	5.30	4.40
8	5.70	4.60
9	6.30	4.80
10	7.00	5.60

Pictures of the slag material were taken after the water was passed through the material. A visible precipitate was seen forming in the water, however, the majority of it was carried away with the water. After the tenth pass, the water from the R-Slag was left to sit and settle for thirty minutes and most, if not all, of the precipitate settled to the bottom of the container.

Wet R-Slag material, no obvious signs of precipitation forming on material.

R-Slag material after air drying for 24 hours.

R-Slag water after 10 passes through a 3" x 24" column. Precipitate layer on bottom of beaker, less than 1% by volume. Precipitate that accumulated in 30 minutes of standing at room temperature.

A second study was conducted to determine the effect of the slag material on standing AMD water, in the event the water would become pooled while in contact with the material. As was previously demonstrated, the P-Slag continued to react with the water, beyond the treatment limits being sought after.

Table 5 details the results of both the R-Slag and the B-Slag when left in contact with the AMD water for extended periods of time.

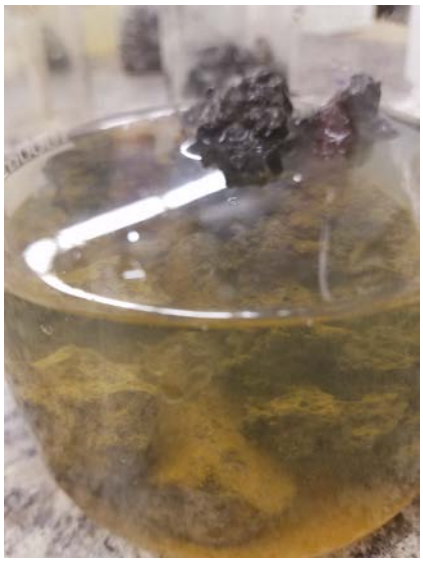
Table 5: Results of slag material in contact with LKA water over extended time

Standing Time, hours	R-Slag, pH	B-Slag, pH
O	2.68	2.68
1	7.40	6.93
24	9.40	9.20
36	9.40	9.90
48	10.7	11.0

The above results indicate that a retention time longer than 1 hour would yield undesirable results for the leachate. A significant amount of precipitate did form in each container, as the pictures indicate. This precipitate did cement upon itself when exposed to the air for 24 hours, however, it did not appear to be cemented directly to the slag material

This is important when compared to the reaction that takes place with the limestone that has been used previously. The precipitates formed by the limestone adhere directly to the material, rendering it ineffective once the surface area is completely coated.

Based upon these findings, a design that allows for clean pass through of the Mine AMD water, with a retention pond to allow for the precipitates to settle out, would be ideal.



B-Slag when subjected to standing LKA water, after 24 hours.

B-Slag when subjected to standing LKA water after one week.

R-Slag when subjected to standing LKA water, after 48 hours.

Top view, showing water hardness coming out and forming a salt precipitate on the surface of the water.

Notice, the precipitate is free floating around the material, not adhered to it.

Based upon the above findings, the R-Slag was identified as the most viable material for the purposes of creating a passive treatment system at the Golden Wonder Mine. Further testing was done with this material to determine the length of time the material might be usable.

Samples of Golden Wonder AMD water were passed through the original R-Slag 3" x 24" column over the course of three months. Observations were made as to the appearance of the slag material, with no obvious signs of deterioration or coating occurring on the material greater than what was originally observed after the first 24 hours. The slag material was allowed to dry out in between subsequent tests, and fresh Mine AMD water with a pH of 2.68 was used for each additional test.

Each test day, three portions of 500 mL each were added to the column for a total of 10 passes. A total number of twenty-five days. These test days were spread out over the period of January 22, 2017 to March 22, 2017.

Table 6 details the resulting pH values seen on the LKA water over the course of the testing days.

Table 6: R-Slag neutralization ability over time. Fresh LKA AMD water used for each test day and test run.

Test Day, Total Volume of LKA Water used	R-Slag, pH
0, 0 mL	2.68
1, 1500 mL	7.22
2, 3000 mL	7.22
3, 4500 mL	7.34
4, 6000 mL	7.20
5, 7500 mL	7.10
10, 15000 mL	7.14
15, 22500 mL	7.22
20, 30000 mL	7.08
25, 37500 mL	7.04

The testing was discontinued due to a lack of additional water. The mine is currently snowed in. After speaking with the mine operators, a real-life test is being planned for the Golden Wonder Mine as soon as the snow melts and discharge water becomes available.

A design that includes a channel containing the R-Slag is suggested, with a concave configuration to force the discharge water to flow through the slag and not around the sides. The water leaching through the slag will then be directed to a holding area where the precipitates may settle out before the water is released and discharged from the outfall location.

At this time, we believe this treatment method has definite viability and are ready to do a field trial study this coming Spring. The water will be monitored closely during this process and the results compiled into a report to validate that the passive treatment process does indeed work under the actual conditions found at the Mine.

As a final validation, three samples of treated water were collected during the 25-day test run and analyzed for the original set of parameters, found in Table 1. These samples were collected on days 5, 15, and 25. The results are found in Table 7.

Enviro-Chem Analytical, Inc.
2493 Hwy 6&50, Unit 7
Grand Junction, CO 81505

Table 7: Post-treatment LKA Water samples. Treated with R-Slag 3" x 24" column with a flow rate of 500 mL/< 1 minute.

Analyte	Orig., ug/L	5-days, ug/L	15 days, ug/L	25 days, ug/L
pH	2.68 s.u.	7.10 s.u.	7.22 s.u.	7.04 s.u.
Aluminum	1350	42	40	46
Arsenic	48	<1.0	<1.0	<1.0
Cadmium	16.7	<0.30	<0.30	<0.30
Chromium	<10	<10	<10	<10
Copper	478	32	29	33
Iron	11200	126	118	139
Lead	39	1.22	1.20	1.23
Manganese	583	38	32	38
Mercury	1.3	0.011	0.010	0.011
Nickel	230	<10	<10	<10
Selenium	14	2.43	2.44	2.43
Silver	<10	<0.05	<0.05	<0.05
Zinc	656	38	36	41

The above results indicate adequate treatment and removal of acidity and metals is occurring at an acceptable rate. Testing during the field trial study will be used to determine possible length of time the slag material can be used before replacement is necessary. A combination of pH values and metals will be used for this purpose.

This completes the report covering the last five months of bench studies involving the Steel Slag materials obtained from Harsco Pueblo Slag Company. As steel slag products vary greatly, this study is specific to the slag materials obtained from Harsco. In the event that slag material is obtained from another source, additional bench studies would be required to validate their effectiveness with Golden Wonder AMD water. This report has been submitted to DOWL engineers for analysis and treatment system design.

Results submitted
for Enviro-Chem Analytical, Inc.
Liese K. Thompson
Liese K. Thompson
Lab Director

APPENDIX E

MATERIAL SPECIFICATIONS

E.1 – STEEL SLAG

E.2 – HDPE TRANSPORT DRUM

E.3 – SMART DITCH®

E.4 - DURA®TRANCH DRAIN

E.5 – AQUA TROLL 600 AND LEVEL TROLL 500

E.1 – STEEL SLAG

CRUSHED ROCK
LIMESTONE GRAVEL ALTERNATIVE

Search site...

HARSCO

MATERIALS | ABOUT US | CONTACT US

What is Steel Slag?

Steel slag is a co-product of steelmaking, with remarkable properties. In terms of mineral composition, it is a calcium silicate, which makes it suitable for many applications.

Steel Making Co-Product

Slag is a co-product of steelmaking

Once it is cooled, weathered and crushed, it has remarkable properties

It can then be graded to different sizes to suit your application needs

Did you know our Crushed Rock is a Green Mineral?
Steel slag is a calcium silicate which comes from a renewable source, making it the Green mineral alternative to quarried rock such as limestone.

Quick Links:

Make an inquiry | Contact us

Our Materials

Aggregate materials for homeowners or Construction Pro's

Learn more

Where to Buy

Where to get Crushed Rock.

Find a location

Downloads

Further information about our materials

Learn more

Talking Materials

View a video of a highway commissioner comparing Limestone and Steel slag for chip seal roads

View chip and seal slag aggregate video

Buy Crushed Rock

Crushed Rock in Blytheville AR
Crushed Rock in Pueblo CO
Crushed Rock in Pittsboro IN
Crushed Rock in Muscatine IA
Crushed Rock in Cofield NC
Crushed Rock in Koppel PA
Crushed Rock in Harrisburg PA
Crushed Rock in Sarver PA
Crushed Rock in Vineyard UT
Crushed Rock in Ontario Canada

Useful Links

Driveway Gravel Calculator
Crushed Rock Downloads
FAQs about Crushed Rock
Email Inquiry

CRUSHED ROCK
LIMESTONE GRAVEL ALTERNATIVE

Search site...

HARSCO

MATERIALS | ABOUT US | CONTACT US

Frequently Asked Questions about Harsco Crushed Rock

If you don't find what you are looking for, why not contact our sales team.

What is Harsco Crushed Rock?

Harsco Crushed Rock is a steel slag aggregate which is hard, durable and drains well. Its cubical shape locks the aggregate together. Used as an alternative to limestone or gravel for driveways, landscaping back yards, chip and seal roads, parking lots, trench backfill, Riprap, culverts and more.

What is steel slag?

Steel slag is a co-product of steelmaking, with remarkable properties. In terms of mineral composition, it is a calcium silicate, which makes it suitable for many applications

How does it compare to limestone or gravel?

Steel slag is a good alternative to limestone or gravel, due to its natural strength and cubical interlocking shape. It is widely used as a fill material in unpaved areas such as driveways, walkways, low-spot repairs, livestock loafing areas, ditch back-fill and on-farm slag pads. Steel slag is often a darker grey color than limestone, but the color of steel slag varies from pale grey to dark greySeller

Where can I buy it?

We supply customers from 12 locations across North America. You can order material directly from your nearest location. We welcome commercial or residential customers. We can also arrange for delivery. Please contact your nearest site for further information. We accept payment by invoice, check or credit card.

Can steel slag be used for any application?
Steel Slag Aggregate is not recommended for use in contained applications, such as under concrete or asphalt or near natural bodies of water. For details regarding Steel Slag Aggregate applications please contact your Harsco Sales Representative.

Our Materials

Aggregate materials for homeowners or Construction Pro's

Learn more

Where to Buy

Where to get Crushed Rock.

Find a location

Downloads

Further information about our materials

Learn more

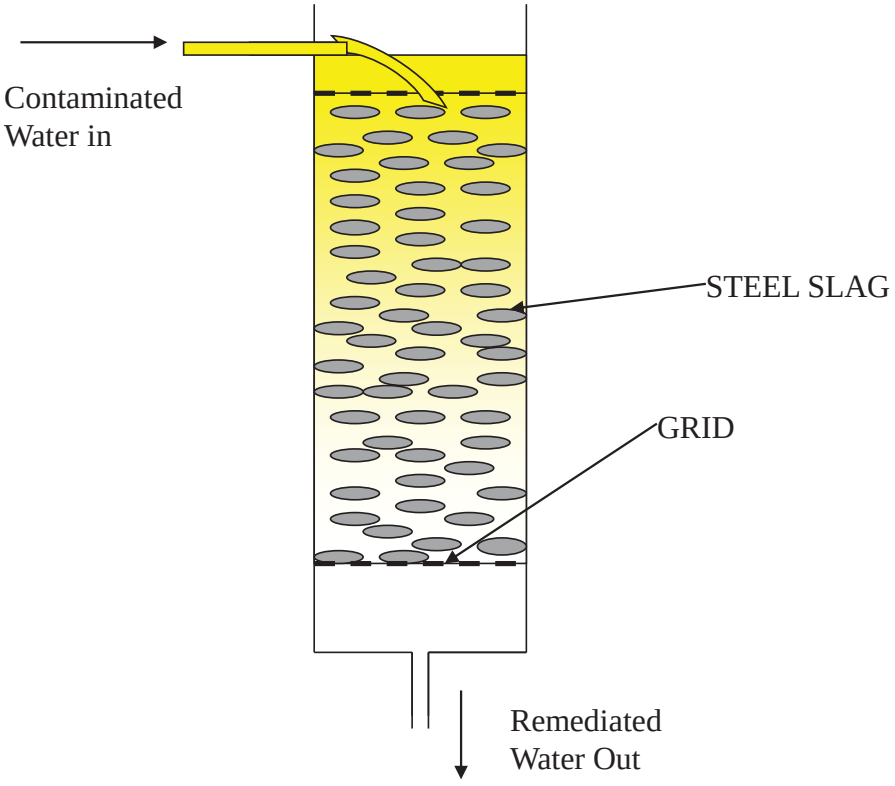
Buy Crushed Rock

Crushed Rock in Blytheville AR
Crushed Rock in Pueblo CO
Crushed Rock in Pittsboro IN
Crushed Rock in Muscatine IA
Crushed Rock in Cofield NC
Crushed Rock in Koppel PA
Crushed Rock in Harrisburg PA
Crushed Rock in Sarver PA
Crushed Rock in Vineyard UT
Crushed Rock in Ontario Canada

Useful Links

Driveway Gravel Calculator
Crushed Rock Downloads
FAQs about Crushed Rock
Email Inquiry

ONE DIMENSIONAL COLUMN SETUP



E.2 – HDPE TRANSPORT DRUM

Material Handling | Drums and Drum Handling Equipment | Barrels, Drums and Covers | Barrels and Drums | 30 gal. Black Polyethylene Closed Head Transport Drum

EMAIL PRINT

Back to Product Family

GRAINGER APPROVED

30 gal. Black Polyethylene Closed Head Transport Drum

Item# **19H062** Mfr. Model# **THO30BLK** Catalog Page# **1180** UNSPSC# **24112109**

List Price
$125.35 / each

Auto-Reorder Every 1 Month
Deliver one time only

1 ADD TO CART

+ Add to List

Confirm ZIP Code to determine availability.

59101 SAVE

Be the first to write a review

Shipping Weight **18.0 lbs.**

Country of Origin **USA** | *Country of Origin is subject to change.*

Note: Product availability is real-time updated and adjusted continuously. The product will be reserved for you when you complete your order. More

How can we improve our **Product Images**?

Compare

TECHNICAL SPECS

Drum Item	**Transport Drum**	Outside Dia.	**19-1/2"**
Drum Head Type	**Closed Head**	Material Thickness	**.140"**
Drum Volume Capacity	**30 gal.**	Bung Hole Dia.	**2" NPT x 2" Buttress Fittings**
Primary Drum Material	**Polyethylene**	Load Capacity	**474 lb.**
UN Rating Liquid	**1H1/Y1.9/150**	Weight	**18 lb.**
Packing Group	**II and III of Hazardous Materials**	For Use With	**Liquids**
Drum Color	**Black**	Lined/Unlined	**Unlined**
Overall Height	**33-7/8"**		

E.3 – SMART DITCH®

SMARTDITCH®

FINALLY, SMARTER SOLUTIONS IN WATER MANAGEMENT.®

Mining & Industrial

The SmartDitch® System

Surface Water Runoff Solution to Protect Valuable Water & Land Resources

PENDA CORPORATION™

SmartDitch® - Protect the Environment and Manage Toxic Water Runoff

Stormwater run off from mining and industrial operations is a big threat to land and water quality in both urban and rural areas. Mining and industrial manufacturing activities produce toxic surface residues that can be found on rocks and sediment or on the paved storage yards of factories, warehouses, scrap yards and transportation hubs. These residues often carry pollutants like heavy metals, pesticides, sulfur and other chemicals. Left unmanaged, these residues can mix with stormwater and contaminants that can be harmful to community stormwater sewer systems as well as the land, local rivers, lakes and coastal waters.

The SmartDitch system is an HDPE channel/ditch lining system that is ideal for permanent and temporary "no contact" water diversions, mining drainage pathways, erosion/sediment control, and industrial site water run off and containment. Compared to traditional channel lining methods, it offers superb corrosion resistance, is long lasting, light weight, less costly and easy to install and maintain.

SmartDitch was the ideal channel design solution to protect the land from chemical infiltration and direct the water and chemical discharges to a containment area.

SmartDitch *Mega*Ditch proved to be the only sustainable solution to channel the stormwater/snow melt run off and solve the erosion issues at this mining operation.

The SmartDitch System is your common sense water run off solution if your facility is involved with mining, manufacturing, fabrication, salvage, hazardous waste treatment, storage or disposal.

Chemical Resistance Chart – Common Substances

Chemical or Substance Material	Polyethylene (73°F/23°C)[1]	HD Polyethylene (68°F/20°C)[2]
Alcohol, ethyl	R	S
Antifreeze agents, vehicle	R	
Bleaching solution, 12.5% active chlorine	R	
Bleaching solution, 5.5% active chlorine	R	
Brake fluid	R	
Diesel fuel	R	
Diesel fuel / oil	R	S
Ethane	R	
Fertilizer salts, aqueous	R	
Fuel oil	R	
Gasoline	R to C	L
Hydraulic fluid / oil	R	
Hydrogen peroxide, aqueous 10% - 90%	R	S
Jet fuels	R	
Mercury, liquid	R	S
Methanol, pure	R	S
Motor oil	R	S
Nitric acid, 0% - 30%	R	S
Nitric acid, >30% - 50%	R to C	L
Petroleum, sour, refined	R	
Sea water	R	S
Selenic acid	R	S
Sewage, residential	R	
Soap solutions, aqueous	R	S
Sulfuric acid, 70% - 90%	R	S
Two stroke engine oil	R	

R = Material is generally resistant (Specimen swells <3% or has weight loss of <0.5% and elongation at break is not significantly changed).

C = Material has limited resistance only and may be suitable for some conditions (Specimen swells 3% - 8% at weight and loss of 0.5% - 5%)

S= Satisfactory. The chemical resistance of HD polyethylene exposed to the action of a fluid is classified as "satisfactory" when the results of test are acknowledged to be "satisfactory" by the majority of the countries participating in the evaluation.

L= Limited. The chemical resistance of HD polyethylene exposed to the action of a fluid is classified as "limited" when the results of test are acknowledged to be "limited" by the majority of the countries participating in the evaluation.

[1]Information gathered from Chemical & Abrasion Resistance of Corrugated Polyethylene Pipe, Corrugated Polyethylene Pipe Association. Though different in physical design, SmartDitch maintains the same resin cell classification as the samples in this report. A more complete listing of polyethylene's chemical resistance can be obtained by contacting the Corrugated Polyethylene Pipe Association.

[2]Chemical Resistance Table Low Density and High Density Polyethylene. Summary of data given in a number of chemical resistance tables at present in use in various countries, derived from both practical experience and test results. ISO/TR 7472, 7474; Carlowitz: "Kunststofftabellen-3. Auflage".

866.576.2783

SMARTDITCH
FINALLY, SMARTER SOLUTIONS IN WATER MANAGEMENT.®

www.smartditch.com

Ultra High Molecular Weight PE Ditch Lining System

SmartDitch® is manufactured, by Penda Corporation, with ultra high molecular weight HDPE resin that provides excellent mechanical properties. These properties are instrumental in providing a durable, flexible, thermoformed plastic ditch-lining system. The following table lists critical testing results on some of the more important design properties. Please contact your SmartDitch sales representative if additional design data is required.

Property	Test Method	*Nominal Values (SI)	*Nominal Values (English)
Density	ASTM D1505	0.949 g/cm^3	0.949 g/cm^3
Melt Mass Flow Rate	ASTM D1238	10 g/10 min	10 g/10 min
Environmental Stress Crack Resistance (ESCR) *Condition A (100% Igepal), F50* *Condition B (10% Igepal), F50*	 ASTM D1693A ASTM D1693B	 600 hr 600 hr	 600 hr 600 hr
Tensile Yield Strength *2"/min, 51 mm/min*	ASTM D638, Type IV	24.8 MPa	3600 psi
Tensile Elongation *2"/min.*	ASTM D638, Type IV	600%	600%
Flexural Modulus (compression molded)	ASTM D790	1170MPa	170,000
Brittleness Temperature	ASTM D746	-90 °C	<-130 °F
Tensile Impact Strength	ASTM D1822	84.1 KJ/m^2	40.2 ft-lb/in^2
Coefficient of Linear Thermal Expansion	ASTM D696	n/a	7 x 10^{-5} in/in/ °F
Cell Classification	ASTM D3350	445540	N/A

** Nominal values are intended to serve as a guide only, and not assumed as the specification limit. Some of the results are based on test specimens and may not reflect the ultimate performance of a full ditch lining system.*

FLOW CALCULATIONS

Flow rate calculations for the channel system are based on the standard hydraulic flow formula:

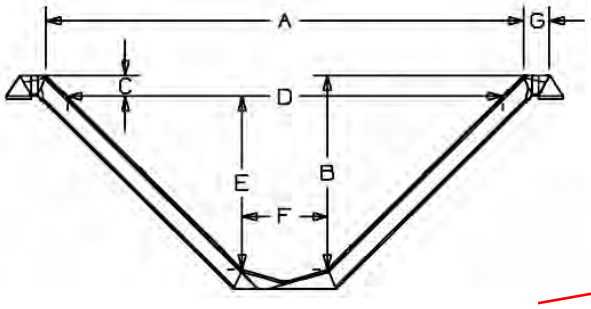
$$Q = (1.49/n)\, A\, R^{2/3}\, S^{1/2}$$

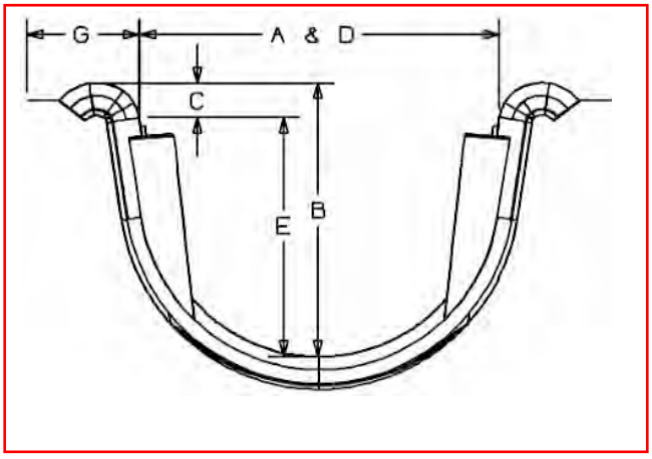
Where:

Q = Total Flow
N = Manning’s Coefficient of Friction (0.022)
A = area (sf)
R = hydraulic radius (ft) [R = A / wetted perimeter] S = slope (%)

To calculate the hydraulic flow area & radius of each SmartDitch size, dimensions are provided below.

ITEM DESCRIPTION	ITEM #	12" DEPTH TRAPEZOIDAL – IN	24" DEPTH TRAPEZOIDAL – IN (MM)	24" DEPTH SEMI-CIRCULAR – IN (MM)
Channel top width	A	37.50 (952.50)	64.25 (1632)	24.00 (609.60)
Channel height (interior)	B	14.50 (368.30)	27.00 (685.80)	16.00 (406.40)
Minimum freeboard	C	1.00 (25.40)	2.00 (50.80)	2.00 (50.80)
Maximum flow area top width	D	34.50 (876.30)	60.00 (1524)	16.00 (406.40)
Maximum flow depth	E	13.50 (342.90)	24.75 (629)	14.00 (355.60)
Bottom channel width (interior)	F	8.00 (203.20)	11.50 (292)	N/A (Rounded Bottom)
Top shoulder width (w/out knuckle)	G	4.50 (114.30)	5.25 (133)	5.00 (127.00)

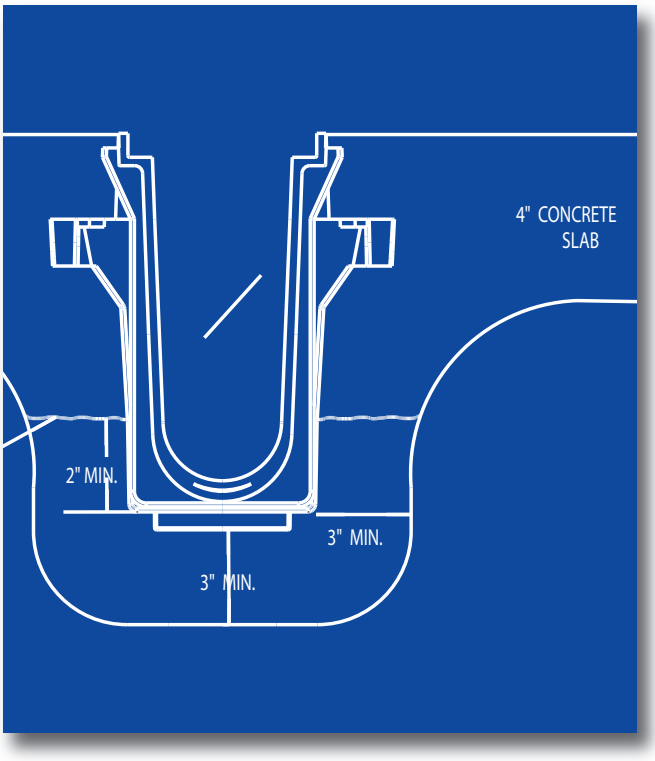




E.4 - DURA®TRANCH DRAIN

TECHNICAL SPECIFICATION GUIDE

DURA SLOPE™



NDS Customer Service
851 N. Harvard Ave, Lindsay, CA 93247
Phone: (800) 726-1994 • (559) 562-9888
Fax: (800) 726-1998 • (559) 562-4488
www.NDSPRO.com

NDS™
WE PUT WATER IN ITS PLACE

TECHNICAL SPECIFICATION GUIDE

DURA SLOPE™

NDS™
WE PUT WATER IN ITS PLACE

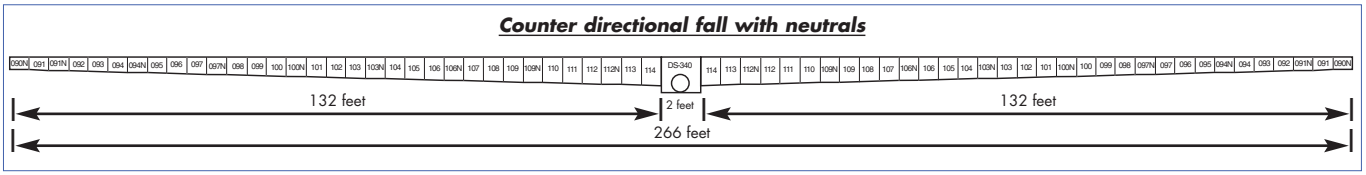
TABLE OF CONTENTS

Overview

NDS is the innovator of exterior surface drainage products. We offer a complete line of catch basins, grates, sewer and drain fittings, and channel drains such as the Dura Slope™ pre-sloped trench drain system. These products are used to collect excess runoff water and dispense it into an underground drainage pipe which then discharges water to street curbs, storm water sewers, drainage ditches or other runoff areas. NDS drainage products can be tied to an existing drain pipe or downspout connection and are essential in maintaining healthy plant and lawn life, as well as protecting man-made structures from damage due to excess ground water. Locating low spots in landscaping, anticipating rainfall, and keeping in mind that water flows downhill are the keys to installing an effective drainage system.

Dura Slope™ is a high-quality structural foam polyethylene trench drain system with a built-in slope. The system has been specifically designed and manufactured to ensure strength, structural integrity and durability while incorporating excellent hydraulic characteristics and chemical resistance. Dura Slope™ is an economical alternative to traditional polymer concrete trench drain systems, while offering ease of installation. The NDS Dura Slope™ is the best choice for a variety of drainage solutions including driveways, parking areas, warehouses, loading docks, gas station entrances, and other areas for the interception and collection of surface run-off.

• Foundations • Tennis Courts • Swimming Pools • Driveways
• Dog Kennels • Garages • Marinas • Saunas and Spas
• Patios • Hot Tubs • Nurseries • Golf Courses • Gas Stations
• Loading Docks • Warehouses • Tracks
...and much more!



Product Specifications

Specify	**Dura Slope™** is a high quality , dependable, and best-in-class trench drain system.
Material	Manufactured from molded, structural foam HDPE with UV inhibitors.
Channel Sizes	48” length, 6” width, 3.998” to 12.062” inner depth range
Grate Sizes	24” length, 6” width
Grate Materials	Stainless Steel, Galvanized Steel, Cast Iron, Ductile Iron, Plastic (structural foam polyolefin
Grate Colors/Finishes	Metallic finishes, black, gray, white, green, sand, red
Load Class	Class A = 1-160 psi. Class B = 61-175 psi. Class C = 176-325 psi. Class D = 326-575 psi. Loads are based on encasing product in concrete and grate selection.
Strength	Material shall withstand a compressive strength of 2900 psi. Material tensile stress shall be 4550 psi and material flexural strength shall be 5800 psi.
Channel Weight Per Unit	Ranges between 7.452 lbs. for shallow channel to 16.06 lbs for deep channel.
Grate Weight Per Unit	Ranges between 2.92 lbs. for polyolefin to 16.0 lbs. for ductile iron.
Unique Product Features	Lower installed cost than polymer concrete. Fewer parts required.
Pre-Sloped Run Lengths	194 feet of continous slope 266 feet w/neutral sections added
Pipe Outlet Sizes	3”, 4”, 6”, 8” Pipe.

Product Features

- Faster and easier to install. Low cost installation.
- Interlocking tongue and groove joints to secure alignment and ensure straight channel runs.
- DuraLoc™ integral joint lock prevents joint movement during installation.
- ProFit™ locking system locks grate to integral frame and supports product in shipping and installation.
- LeveLoc™ re-bar supports with integral protruding knob levels channel and grips rebar requiring fewer accessories.
- Various grating options; ADA compliant. Stainless steel, galvanized, cast iron, and plastic grates available.
- Decorative grates available in five different designs: weave, tile, brick, diamond, and slot.
- Blank grate inserts that eliminates use of plywood. Slides for overlapping of channel sections, and includes grate screws.
- Made of HDPE material for high durability. Durable, traffic rated up to H20 rating.
- Dura Slope™ installs in a snap without clamps or screws.
- Lower installed cost than polymer concrete. Fewer parts required.
- Light in weight, Dura Slope™ channels can be installed by one person.
- Counter directional fall up to 194 ft., up to 266 ft. with neutrals added.
- Bottom outlet on each channel section. System versatility that requires fewer accessories.
- Universal catch basin.

Material Composition

Dura Slope™ Pre-Sloped Trench Drain

Dura Slope™ shall be manufactured from molded, structural foam polyethylene with UV inhibitors and shall have a nominal outside top dimension of 6-5/8"(168.3mm). Trench drain shall have an inside nominal flow path width of 4"(101.6mm), and shall have a bottom radius of 2" (50.8mm) to facilitate sediment removal. The system shall include neutral and pre-sloped sections to provide variable trench depth as required by site conditions. Pre-sloped sections shall have a slope of 0.7%.

Dura Slope™ channel and grating shall be designed to withstand loads up to Load class D (up to 575psi), when installed per the appropriate installation methods (see NDS installation instructions and grating specifications included in the Dura Slope™ catalog). Channel grating shall be installed per manufacturer load rating recommendations, and shall be attached to the channel using stainless steel screws with the manufacturer-supplied Pro Fit™ locking system. The channel shall include LeveLoc™ integral re-bar supports located at 24" (60cm) intervals along each side of the channel to provide height adjustment using #4 re-bar (1/2") during installation. The channel shall have tongue and groove Dura Loc™ joints that ensure precise alignment during installation with snap-lock mechanisms to eliminate joint movement.

Molding Technique

Dura Slope™ is proudly manufactured in the U.S.A. in Lindsay, California. The channels are injection molded to exacting specifications to an exact temperature range that will not damage the molecular chain of the polymer. The use of high quality resins coupled with computerized manufacturing technologies guarantees the Dura Slope™ channel drain system will preserve in strength over time.

Testing Methods

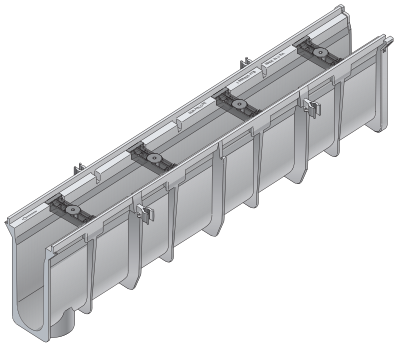
The Dura Slope™ channel and grates undergo a battery of tests with each production run, as is the process with all of the products manufactured by NDS. All of the manufacturing tests are conducted within the manufacturing cycle to assure a quality-finished product.

Compression Tests

Compression tests are used to determine the load strength of NDS channel drains. Material absorption rate shall not exceed .01%. Material shall withstand a compressive strength of 2900 psi. Material tensile stress shall be 4550 psi and material flexural strength shall be 5800 psi. The Dura Slope™ System has the ability to withstand freeze/thaw cycles and provide chemical resistance, including road salt.

DURA SLOPE™
CHANNEL DRAINS

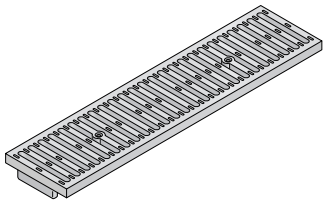
NDS Dura Slope™ is a 6⅝" wide, 4-foot-long trench drain system with a built-in slope of 0.7%. Each channel section is molded of gray structural foam polyethylene with UV inhibitors and has a 4" inside diameter with a 2" radius bottom. The system consists of 4-foot channel sections including 24 pre-sloped channel sections and 9 neutral channel sections. The sloped channel sections enable the system to extend to a length of 96 feet with a continuous slope.

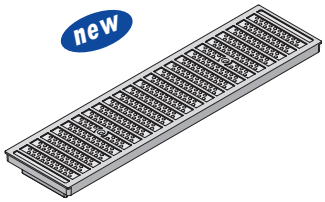


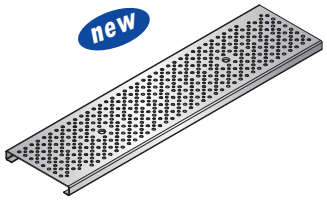
Part No.	Description	Flow Rate GPM	Min. Inner Depth	Max. Inner Depth	Min. Outer Depth	Max. Outer Depth	Wt. Ea. (lbs.)
DS-090N	3.99" Deep Neutral Dura Slope Channel	75	3.998	3.998	5.354	5.760	7.45
DS-091	3.99" to 4.34" Deep Dura Slope Channel	75	3.998	3.998	5.690	5.770	7.52
DS-091N	4.34" Deep Neutral Dura Slope Channel	89	4.334	4.334	5.692	6.103	7.81
DS-092	4.34" to 4.67" Deep Dura Slope Channel	89	4.334	4.670	6.062	6.106	7.92
DS-093	4.67" to 5.00" Deep Dura Slope Channel	103	4.670	5.006	6.362	6.442	8.27
DS-094	5.00" to 5.34" Deep Dura Slope Channel	117	5.006	5.342	6.698	6.778	8.64
DS-094N	5.34" Deep Dura Slope Channel	131	5.342	5.342	6.700	7.111	8.93
DS-095	5.34" to 5.68" Deep Dura Slope Channel	131	5.342	5.678	7.034	7.114	8.99
DS-096	5.68" to 6.01" Deep Dura Slope Channel	145	5.678	6.014	7.370	7.450	9.36
DS-097	6.01" to 6.35" Deep Dura Slope Channel	159	6.014	6.350	7.706	7.786	9.74
DS-097N	6.35" Deep Neutral Dura Slope Channel	173	6.350	6.350	7.708	8.119	10.04
DS-098	6.35" to 6.69" Deep Dura Slope Channel	173	6.350	6.686	8.042	8.122	10.11
DS-099	6.69" to 7.02" Deep Dura Slope Channel	187	6.686	7.022	8.378	8.458	10.48
DS-100	7.02" to 7.36" Deep Dura Slope Channel	201	7.022	7.358	8.714	8.794	10.86
DS-100N	7.36" Deep Neutral Dura Slope Channel	215	7.358	7.358	8.716	9.127	11.16
DS-101	7.36" to 7.69" Deep Dura Slope Channel	215	7.358	7.694	9.050	9.130	11.23
DS-102	7.69" to 8.03" Deep Dura Slope Channel	229	7.694	8.030	9.386	9.466	11.60
DS-103	8.03" to 8.37" Deep Dura Slope Channel	243	8.030	8.366	9.722	9.802	11.98
DS-103N	8.37" Deep Neutral Dura Slope Channel	257	8.366	8.366	9.724	10.135	12.27
DS-104	8.37" to 8.70" Deep Dura Slope Channel	257	8.366	8.702	10.058	10.138	12.34
DS-105	8.70" to 9.04" Deep Dura Slope Channel	271	8.702	9.038	10.394	10.474	12.71
DS-106	9.04" to 9.37" Deep Dura Slope Channel	285	9.038	9.374	10.730	10.810	13.07
DS-106N	9.37" Deep Neutral Dura Slope Channel	299	9.374	9.374	10.732	11.143	13.39
DS-107	9.37" to 9.70" Deep Dura Slope Channel	299	9.374	9.710	11.066	11.146	13.4
DS-108	9.70" to 10.05" Deep Dura Slope Channel	313	9.710	10.046	11.402	11.482	13.83
DS-109	10.05" to 10.38" Deep Dura Slope Channel	327	10.046	10.382	11.738	11.818	14.20
DS-109N	10.38" Deep Neutral Dura Slope Channel	341	10.382	10.382	11.740	12.151	14.50
DS-110	10.38" to 10.71" Deep Dura Slope Channel	341	10.382	10.718	12.074	12.154	14.57
DS-111	10.71" to 11.05" Deep Dura Slope Channel	355	10.718	11.054	12.410	12.490	14.95
DS-112	11.05" to 11.39" Deep Dura Slope Channel	368	11.054	11.390	12.746	12.826	15.32
DS-112N	11.39" Deep Neutral Dura Slope Channel	382	11.390	11.390	12.785	13.158	15.6
DS-113	11.39" to 11.72" Deep Dura Slope Channel	382	11.390	11.726	13.082	13.162	15.69
DS-114	11.72" to 12.06" Deep Dura Slope Channel	396	11.726	12.062	13.418	13.498	16.06

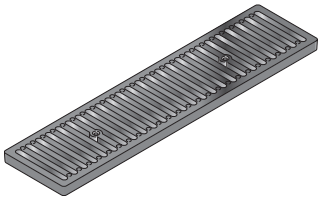
Note: All dimensions are nominal. All weights are for shipping purposes only. Availability is subject to change.

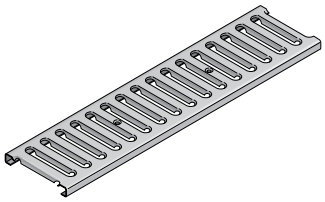
DURA SLOPE™
GRATES











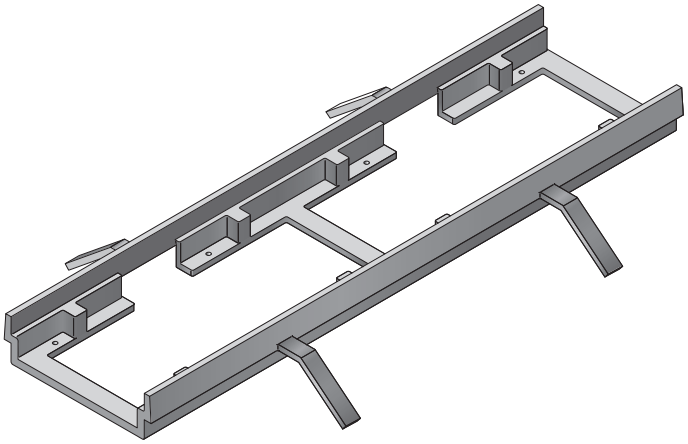
Part No.	Description	Color	Pkg. Qty.	Wt. Ea. (lbs.)	Inflow Capacity (GPM)	Specifications
660	2 ft. Channel Grate	White	12	2.92	27	NDS #660, #661, #662, #663, #664, #665, 2 ft. Structural Foam Polyolefin secured channel grate with UV inhibitor. Open surface area of 20.61 square inches per foot. 27.00 GPM per foot.
661	2 ft. Channel Grate	Dark Gray	12	2.92	27	
661LG	2 ft. Channel Grate	Gray	12	2.92	27	
662	2 ft. Channel Grate	Green	12	2.92	27	
663	2 ft. Channel Grate	Black	12	2.92	27	
664	2 ft. Channel Grate	Sand	12	2.92	27	
665	2 ft. Channel Grate	Brick Red	12	2.92	27	
DS-670	2 ft. Plastic Perforated Channel Grate	Gray	12	3.0	11.3	NDS #DS-670, 2' Structural Foam Polyolefin, secured channel grate with UV inhibitors; light traffic rated, heel-proof, ADA compliant. Open surface area of 9.36 square inches per foot; 12.2 GPM per foot.
DS-226	2 ft. Stainless Steel Perforated Channel Grate	Steel	12	3.22	9.6	NDS #DS-226, Stainless Steel grate, light traffic rated, heel-proof, ADA compliant. Open surface area of 7.92 square inches per foot; 10.4 GPM per foot.
DS-228	2 ft. Galvanized Steel Perforated Channel Grate	Steel	12	3.22	9.6	
DS-231	2 ft. Cast Iron Channel Grate	Black	1	15.00	22.6	#DS-231 2 ft. Heavy Duty Cast Iron Channel Grate. NDS #DS-232, 2 ft. Heavy Duty Ductile Iron Channel Grate. Open surface area of 15.27 square inches per foot; 20.00 GPM per foot. H-20 Load Rating.
DS-232	2 ft. Ductile Iron Channel Grate	Black	1	16.00	22.6	
DS-221	2 ft. Galvanized Steel Channel Grate	Steel	12	4.00	31.4	NDS #DS-221, 2 ft. Galvanized Rolled Steel Grate. Open surface area of 19.85 square inches per foot; 26.00 GPM per foot.

ADA Compliant

Use with Dura Slope Drains and Dura Slope Catch Basins

DURA SLOPE™
DUCTILE IRON FRAME

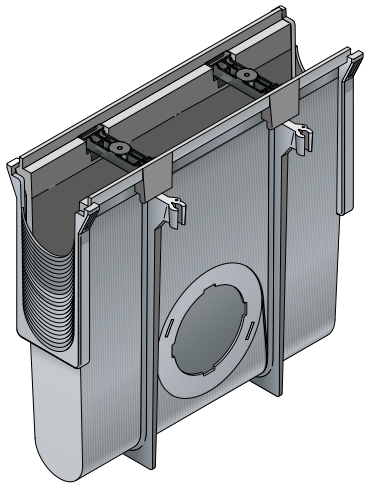
Dura Slope™ Ductile Iron Frame provides a Class D load rating of 326-575 psi and is suitable for heavy-duty hard tire equipment at speeds less than 20 mph. The DS-200 Ductile Iron Frame is recommended for use with pneumatic tire traffic such as fork lifts. The ductile iron frame can be used with the cast and ductile iron grates.



Part No.	Description	Color	Pkg. Qty.	Wt. Ea. (lbs.)	Product Class
DS-200	Dura Slope™ Ductile Iron Frame	Black	1-2 ft	7.50	25DS
Note: All dimensions are nominal. All weights are for shipping purposes only. Availability is subject to change.					

DURA SLOPE™
CATCH BASIN

The NDS Dura Slope™ in-line catch basin is designed to fit all depth ranges of the Dura Slope™ trench drain sections. Catch basin inlets are designed to be sized as required to accept the Dura Slope™ trench drain section. The Dura Slope™ catch basin is 2 feet long and 2 feet deep with an outlet on both sides of the basin. One Universal Adapter Plug, one blank grate insert and two grate screws are included with each Dura Slope™ in-line catch basin. The NDS universal basin outlets are used to adapt the catch basin to 3″, 4″, 6″ and 8″ pipe.



Part No.	Description	Color	Pkg. Qty.	Wt. Ea. (lbs.)	Product Class
DS-340	Dura Slope™ In-Line Catch Basin DS-340 Available for use of one or two outlets Use #1242, #1243, #1245, #1266, #1206, or #1888 Universal Outlets	Gray	1	12.00	25DS

Note: All dimensions are nominal. All weights are for shipping purposes only. Availability is subject to change.

Chemical Resistance

The following results were derived from testing using standard procedures including ASTM D543 "Standard Test Method for Resistance of Plastics to Chemical Reagents." Actual results will vary for different applications depending on environmental conditions for each particular application and other modifying factors. The following table assumes ambient temperature of 75 degrees Fahrenheit.

The comparative information presented considers the environmental and stress-cracking tendencies of the polymeric material. Sunlight can be destructive because of its ability to cleave main chain bonds of polymers. When specifying plastic products for outdoor use, include the requirement for NDS products with ultra-violet stabilizers to protect against deterioration and discoloration due to exposure to sunlight.

NDS Chemical Resistance Guide

		NDS Plastic Materials @ max. Temp (°F) or Rating				Metals Rating			Flo Control Gaskets @ max. Temp (°F) or Rating		
Chemicals	%	ABS	Polyolefin	Polystyrene	PVC	Brass	Cast Iron	Ductile Iron	EPDM	Buna-n	Viton
Acetic Acid	25	-	180	A	73	C	C	C	180	C	C
Acetic Acid	50	-	140	A	73	C	C	C	140	C	C
Acetic Acid	80	-	100	B	73	C	C	C	100	C	C
Acetone	-	-	73	C	C	A	A	A	130	C	C
Aluminum Chloride	Sat	-	180	A	140	C	C	C	210	70	150
Aluminum Fluoride	Sat	-	-	B	73	C	C	C	210	180	-
Aluminum Sulfate	Sat	-	180	B	140	C	C	C	210	200	150
Ammonium Acetate	Sat	-	73	B	140	C	-	-	140	-	-
Ammonium Chloride	Sat	-	180	A	140	C	C	C	210	180	A
Ammonium Hydroxide	10	-	180	B	225	C			210	70	A
Ammonium Sulfate	-	-	180	A	140	C	B	B	210	180	A
Amyl Alcohol	-	-	180	A	100	A	B	B	210	140	A
Barium Chloride	Sat	-	180	A	180	A	B	B	250	180	A
Barium Hydroxide	Sat	-	180	-	140	A	B	B	250	180	A
Benzene	-	-	C	C	C	A	A	A	C	C	A
Benzoic Acid	All	-	140	A	140	C	C	C	C	C	-
Borax	Sat	-	180	A	140	A	A	A	210	140	A
Boric Aid	Sat	-	180	A	140	B	B	C	210	140	A
Calcium Chloride	-	100	180	A	140	B	A	A	210	100	A
Calcium Hydroxide	-	-	180	-	140	C	C	C	210	140	A
Carbon Tetrachloride	-	-	C	-	73	A	C	C	C	C	A
Chlorine Gas (Dry)ppm	<150	-	C	B	120	C	B	A	C	C	B
Chlorine Gas (Wet) ppm	>150	C	C	B	120	C	C	C	C	C	B
Chlorinated Water ppm	<3500	-	-	B	140	C	-	-	B	C	B
Chlorinated Water ppm	>3500	-	C	B	C	C	-	-	C	C	B
Chromic Acid	10	C	150	B	140	C	C	C	70	C	B
Chromic Acid	30	C	150	B	140	C	C	C	C	C	-
Chromic Acid	40	C	150	B	140	C	C	C	C	C	-
Chromic Acid	50	C	C	B	75	C	C	C	C	C	-
Citric Acid	Sat	-	180	A	140	C	C	C	210	70	A
Copper Chloride	Sat	-	-	-	140	C	C	C	210	180	150
Copper Cyanide	-	-	-	-	140	C	C	C	210	180	-
Copper Nitrate	30	-	-	-	140	C	C	C	210	B to 70	-
Copper Sulfate	Sat	-	120	A	140	C	C	C	210	180	150
Creosote	-	-	-	-	73	B	A	A	C	73	B
Crude Oil	-	-	-	-	140	C	C	C	C	70	-
Dibutyl Ether	-	-	-	-	-	-	-	-	C	C	C
Diesel Fuel	-	-	-	-	140	A	A	A	C	70	-
Ethyl Alcohol	-	-	180	-	140	A	A	A	170	180	A

NDS Chemical Resistance Guide

		NDS Plastic Materials @ max. Temp (°F) or Rating				Metals Rating			Flo Control Gaskets @ max. Temp (°F) or Rating		
Chemicals	%	ABS	Polyolefin	Polystyrene	PVC	Brass	Cast Iron	Ductile Iron	EPDM	Buna-n	Viton
Ethyl chloride	Dry	-	73	C	C		A	A	B to 70	C	B
Ethylene Glycol	-	-	120	A	140	A	A	A	210	180	A
Ethyl Ether	-	-	C	-	C	-	-	-	C	C	-
Fatty Acids	-	-	120	-	140	C	C	C	C	140	-
Formic Acid	-	-	73	B	73	-	C	C	200	C	C
Fructose	-	-	-	-	140	-	A	A	175	140	-
Gasoline(Leaded)	-	-	C	C	C	A	A	A	C	70	A
Gasoline(Unleaded)	-	-	C	C	C	A	A	A	C	70	A
Glycerine	-	-	180	A	140	A	A	A	200	70	A
Hydrolic Oil	-	-	-	-	73	-	A	A	C	C	-
Hydrobromic Acid	20	-	120	-	140	C	C	C	140	C	-
Hydrobromic Acid	50	-	-	-	140	C	C	C	140	C	-
Hydrochloric Acid	<25	-	150	B	140	C	C	C	150	C	-
Hydrochloric Acid	37	-	150	B	140	C	C	C	150	C	-
Hydrocyanic Acid	10	-	73	-	140	C	C	C	200	70	-
Hydrogen Peroxide	50	-	150	A	140	C	C	C	100	C	A
Hydrogen Peroxide	90	-	-	A	140	C	C	C	C	C	B
Inks	-	-	-	-	-	C	C	C	-	70	-
Jp-4 Fuel	-	-	-	-	C	A	A	A	C	70	A
Kerosene	-	C	73	C	140	A	A	A	C	140	A
Lactic Acid	25	-	150	A	140	C	C	B	70	-	A
Lactic Acid	80	-	150	A	73	C	C	B	70	C	A
Lead Acetate	Sat	-	180	A	140	-	C	C	210	70	-
Linseed Oil	-	-	150	A	140	A	A	A	B to 70	180	A
Magnesium Chloride	Sat	-	180	A	140	B	C	C	170	180	150
Magnesium Sulfate	-	-	180	A	140	A	A	A	175	180	150
Mercury	-	-	150	A	140	C	A	A	210	140	A
Mineral Oil	-	70	120	-	140	A	A	A	C	140	A
Naphtha	-	B to 70	73	C	140	-	A	A	C	140	-
Nickel Sulfate	Sat	-	180	A	140	-	C	C	210	-	150
Nitric Acid	<10	73	140	B	140	C	C	C	70	C	B
Nitric Acid	30	C	73	B	140	C	C	C	70	C	B
Nitric Acid	40	C	C	B	100	C	C	C	C	C	B
Nitric Acid	50	C	C	B	100	C	C	C	C	C	B
Nitric Acid	70	C	C	B	73	C	C	C	C	C	B
Nitric Acid	fuming	C	C	C	C	C	C	C	C	C	B
Nitrous Acid	10	-	-	-	73	C	C	C	-	C	-
Oxalic Acid	50	-	180	A	140	-	C	C	150	C	A
Phosphoric Acid	10	-	180	A	140	C	C	C	140	70	A
Phosphoric Acid	50	-	180	A	140	C	C	C	70	C	A
Phosphoric Acid	85	-	180	A	140	C	C	C	70	C	-
Phosphorus Trichloride	-	-	-	-	C	-	-	-	-	C	-
Picric Acid	10	C	170	-	170	C	C	C	140	C	-
Potassium Bicarbonate	Sat	-	170	-	140	-	-	-	170	70	-
Potassium Bromide	-	-	180	A	140	-	C	C	170	180	-
Potassium Carbonate	-	70	140	A	280	B	A	A	170	180	-
Potassium Chlorate	-	-	180	A	140	-	A	A	140	B to 70	-
Potassium Chloride	-	-	180	A	140	A	B	B	210	180	A
Potassium Cyanide	-	-	-	-	140	C	B	B	140	180	A
Potassium Dichromate	Sat	-	-	B	140	-	B	B	170	180	-
Potassium Ferricyandide	-	-	-	-	140	-	B	B	140	70	-
Potassium Hypochlorite	-	C	C	-	140	-	-	-	C	C to 70	-
Potassium Iodide	-	-	73	-	-	-	-	-	140	100	-
Potassium Nitrate	-	-	-	A	140	B	B	B	210	180	-
Potassium Sulfate	-	-	180	A	140	B	A	A	210	140	A

NDS Chemical Resistance Guide

		NDS Plastic Materials @ max. Temp (°F) or Rating				Metals Rating			Flo Control Gaskets @ max. Temp (°F) or Rating		
Chemicals	%	ABS	Polyolefin	Polystyrene	PVC	Brass	Cast Iron	Ductile Iron	EPDM	Buna-n	Viton
Silver Cyanide	-	-	-	-	140	C	C	C	140	C	-
Sodium Acetate	Sat	-	180	A	140	-	B	B	170	C	-
Sodium Bicarbonate	-	70	180	-	140	B	A	A	250	180	A
Sodium Borate	Sat	-	73	A	-	-	B	B	140	70	-
Sodium Bromide	Sat	-	180	A	140	-	C	C	210	70	-
Sodium Chloride	-	-	180	A	140	A	B	B	140	140	A
Sodium Fluoride	-	-	185	A	140	-	C	C	140	70	-
Sodium Hydroxide	<10	140	180	A	140	-	-	-	180	140	A
Sodium Hydroxide	30	70	180	A	140	-	-	-	140	100	B
Sodium Hydroxide	50	70	180	A	140	-	-	-	140	C	B
Sodium Hydroxide	70	C	180	A	140	-	-	-	70	C	B
Sodium Nitrate	Sat	-	180	B	140	B	A	A	210	140	A
Sodium Peroxide	-	-	-	-	140	C	C	C	140	B to 70	A
Sour Crude Oil	-	-	-	-	140	-	A	A	C	C	-
Stannic Chloride	-	-	-	-	140	C	C	C	100	140	A
Stannous Chloride	15	-	-	-	140	C	C	C	70	140	A
Stearic Acid	-	-	73	A	140	-	-	-	C	140	A
Succinic Acid	-	-	150	-	140	-	A	A	70	70	-
Sugar	-	-	-	-	140	-	-	B	100	140	-
Sulfur	-	-	C	A	140	C	B	B	-	C	B
Sulfur Chloride	-	-	C	-	-	C	C	C	C	70	A
Sulfuric Acid	to 30	100	180	A	140	C	C	C	140	C	A
Sulfuric Acid	50	70	150	A	140	C	C	C	70	140	A
Sulfuric Acid	60	C	150	A	140	C	C	C	C	C	A
Sulfuric Acid	70	C	120	A	140	C	C	C	C	C	A
Sulfuric Acid	80	C	73	A	140	C	C	C	C	C	A
Sulfuric Acid	90	C	C	B	100	C	C	C	C	C	A
Sulfuric Acid	93	C	C	B	100	C	C	C	C	C	A
Sulfuric Acid	94	C	C	B	100	C	C	C	C	C	A
Sulfuric Acid	95	C	C	B	100	C	C	C	C	C	A
Sulfuric Acid	96	C	C	B	100	C	C	C	C	C	--
Sulfuric Acid	98	C	C	B	C	C	C	C	C	C	-
Sulfuric Acid	fuming	C	C	B	C	C	C	C	C	C	A
Sulfurous Acid	Sat	C	140	-	140	C	C	C	75	-	A
Tannic Acid	10	C	180	A	140	B	B	C	70	100	A
Tartic Acid	-	-	-	A	150	C	C	C	C	70	A
Titanium Tetrachloride	-	-	-	-	C	-	-	--	C	-	-
Trichloroacetic Acid	-	-	150	-	140	-	C	C	70	B to 70	-
Turpentine	-	-	C	C	140	A	A	A	C	70	A
Vinegar	-	73	180	A	140	C	C	C	180	C	-
Xylene	-	C	C	C	C	A	A	A	C	C	A
Zinc Chloride	-	-	180	A	140	--	C	C	180	70	A
Zinc Sulfate	-	-	180	A	140	-	C	C	180	140	A

Interpretation of Comparative Ratings as follows:

Temperatures are in °F = Max. Temperature recommended
A = Suitable for use
B to (Temp.) = Contact manufacturer
C = Strongly affected, not recommended
Blank = No information is available

DISCLAIMER: Further Chemical Compatibility results can be looked up by NDS Technical Service by request: (888) 825-4716. This guideline made by NDS is only meant to be used as a reference and does not carry any warranty. It's recommended that you contact the manufacturer or supplier of these chemicals and follow handling instructions for all materials.

E.5 – AQUA TROLL 600 AND LEVEL TROLL 500

Aqua TROLL® 600 Multiparameter Sonde

Reduce operational expenses with this customizable, powerful, and easy-to-use multiparameter sonde. The Aqua TROLL 600 combines unique industry-leading water quality technology, built-in LCD display, and revolutionary smartphone mobility. Low power consumption and advanced antifouling for up to 9+ month deployment supports long-term installation in any application.

The Aqua TROLL 600 water quality platform is rugged in groundwater and corrosion-resistant in surface water, delivering accurate, reliable data in an easy-to-use, flexible instrument that performs for years. Base sensor configuration includes EPA-approved optical dissolved oxygen, pH/ORP, turbidity, conductivity, temperature, and pressure. Integrate with In-Situ telemetry systems and HydroVu™ Data Services for real-time feedback on your remote monitoring sites.

Be Mobile

- **Use the Aqua TROLL 600 anywhere:** Titanium components and vented or non-vented options make it perfect for challenging environments and long-term deployments in fresh and salt water. Every detail has been engineered to be easy, reliable, and cost-effective.
- **Save time in the field:** Intuitive software simplifies instrument configuration, data analysis, and reporting. No training required, and no waiting for sensor warm-up or set-up.
- **Streamline data management**: Set up logs and manage data from the field using the VuSitu™ Mobile App. Consolidate all site information on your mobile device and tag sites with photos and GPS coordinates. Log data to your smartphone and download results in a standard file format for profiling, low-flow sampling, and more.

Be Smart

- **Status in an instant**: LCD display gives you an instant visual indication of sensor status, data log, battery life, and overall functionality to give confidence during deployment. The onboard SD card allows for quick and easy data backup and transfer.
- **No fuss antifouling**: Antifouling to protect all sensors. The only multiparameter sonde to have a sub-2 inch active antifouling system with cleanable conductivity.
- **Get accurate results**: Self-compensating tubidity/RDO/level, smart diagnostics, and stable sensor technology provide minimal drift and increased accuracy with NIST-traceable factory calibration report. Smart sensors store information internally, maintaining data and calibration within the sensor for traceable results.

Be In-Situ

- Receive 24/7 technical support and online resources.
- Order products and accessories from the In-Situ website.
- Get guaranteed 7-day service for maintenance (U.S.A. only).

Applications

- **Lake, stream and wetland monitoring**
- **Stormwater management**
- **Coastal deployments**
- **Dam monitoring**
- **Low-flow groundwater sampling**
- **Remediation and mine water monitoring**

Aqua TROLL® 600 Multiparameter Sonde

Spec Sheet

In-Situ

General

Operating Temperature (non-freezing)	-5 to 50° C (23 to 122° F) ISE: Ammonium & Nitrate 0 to 40° C ; Chloride 0 to 50° C	***Reading Rates***	1 reading every 2 seconds 1 parameter, no wiping
Storage Temperature	Components w/o fluid: -40° C to 65° C (non-freezing water); pH/ORP: -5° C to 65° C; Ammonium/Nitrate: 0 to 40 ° C; Chloride: 0 to 50° C	***Data Logging***	50 logs (defined, scheduled to run, or stored)
Dimensions	4.7 cm (1.85 in.) OD x 59.2 cm (23.3 in.) (includes connector) With bail: 72.9 cm (28.7 in.)	***Logging Modes***	Linear, Linear Average, Event
Weight	1.45 kg / 3.2 lbs (includes all sensors, batteries, and bail)	***Logging Rate***	1 minute to 99 hours
Wetted Materials	PC, PC alloy, Delrin™, Santoprene™, Inconel™, Viton™, Titanium, Platinum, Ceramic, Nylon	***Hex Screw Driver***	0.050, 1.3 mm
Environmental Rating	IP68 with all sensors and cable attached IP67 without the sensors, battery cover or cable attached	***Communication Device***	TROLL Com or Wireless TROLL Com
Max Pressure Rating	Up to 350 PSI	***Cable Options***	Vented or non-vented polyurethane or vented Tefzel®
Output Options	RS-485/MODBUS, SDI-12, Bluetooth®	***LCD Display***	Integrated display shows status of sonde, sensor ports, data log, battery and connectivity.
Internal Memory[1] ***Micro SD Card[2]***	16 MB; 8+ GB micro SD card included, user replaceable	***Software***	Android™: VuSitu through Google Play™, Windows®: Win-Situ 5, Data Services: HydroVu
Internal Power Battery Life[3]	2 internal user-replaceable Alkaline D batteries >6 months typical with wiping >9 months typical with no wiping	***Interface***	Android 4.4, requires Bluetooth 2.0; Win-Situ 5 Software
External Power Voltage ***External Power Current[4]***	8-36 VDC (not required for normal operation) Sleep: 0.10 mA typical Measurement: 16 mA typical, 45 mA max	***Certifications***	CE, FCC, WEEE, RoHS Compliant

Standard Sensors	**Accuracy**	**Range**	**Resolution/Precision**	**Response Time**	**Units of Measure**	**Method**
Temperature[5]	± 0.1° C	-5 to 50° C (23 to 122° F)	0.01° C	T63<2s, T90<15s, T95<30s	Celsius or Fahrenheit	EPA 170.1
Barometric Pressure	± 1.0 mbars	300 to 1,100 mbar	0.1 mbar	T63<1s, T90<1s, T95<1s	Pressure: psi, kPa, bar, mbar, inHg, mmHg	Silicon strain gauge
pH[6]	±0.1 pH unit or better	0 to 14 pH units	0.01 pH	T63<3s, T90<15s, T95<30s	pH, mV	Std. Methods 4500-H+/ EPA 150.2
ORP[7]	±5 mV	±1,400 mV	0.1 mV	T63<3s, T90<15s, T95<30s	mV	Std. Methods 2580
Conductivity[8]	+/-0.5% of reading plus 1 µS/cm from 0 to 100,000 µS/cm; +/-1.0% of reading from 100,000 to 200,000 µS/cm	0 to 350,000 µS/cm	0.1 µS/cm	T63<1s, T90<3s, T95<5s	Actual conductivity (µS/cm, mS/cm); Specific conductivity (µS/cm, mS/cm); Salinity (PSU); Total dissolved solids (ppt, ppm); Resistivity (Ohms-cm); Density (g/cm3)	Std. Methods 2510/ EPA 120.1
TDS (derived from conductivity and temp)	-	0 to 350 ppt	0.1 ppt	-	ppt, ppm	-
Salinity (derived from conductivity and temp)	-	0 to 350 PSU	0.1 PSU	-	PSU, ppt	Std. Methods 2520A
Rugged Dissolved Oxygen (RDO) with RDO-X[9]	±0.1 mg/L ±0.2 mg/L ±10% of reading	0 to 8 mg/L 8 to 20 mg/L 20 to 50 mg/L	0.01 mg/L	T63<15s, T90<45s, T95<60s	mg/L, % saturation, ppm	EPA-approved In-Situ Methods: 1002-8-2009, 1003-8-2009, 1004-8-2009
Turbidity	±2% of reading or ±2 NTU, FNU, whichever is greater	0 to 4,000 NTU	0.01 NTU (0 to 1,000); 0.1 NTU (1,000 to 4,000)	T63<1s, T90<1s, T95<1s	NTU, FNU	ISO 7027
TSS (derived from turbidity)[10]	-	0 to 1,500 mg/L	0.1 mg/L	-	ppt, mg/L	-
Ammonium (NH_4^+ - N)[11,12] Rated to 25m depth	±10% or ±2 mg/L w.i.g.	0 to 10,000 mg/L as N	0.01 mg/L	T63<1s, T90<10s, T95<30s	mg/L, ppm, mV	-
Unionized Ammonia, Total Ammonia (derived from Ammonium & pH sensor)		0 to 10,000 mg/L as N	0.01 mg/L	-	mg/L, ppm	-
Nitrate (NO_3^- - N)[11] Rated to 25m depth	±10% or ±2 mg/L w.i.g.	0 to 40,000 mg/L as N	0.01 mg/L	T63<1s, T90<1s, T95<1s	mg/L, ppm, mV	Std. Methods 4500 NO_3 D
Chloride (Cl^-)[11]	±10% or ±2 mg/L w.i.g.	0 to 150,000 mg/L as Cl	0.01 mg/L	T63<1s, T90<10s, T95<30s	mg/L, ppm, mV	Std. Methods 4500 Cl^- D
Pressure[13] (Optional)	±0.1% full scale (FS)	Non-Vented or Vented 9.0 m (30ft) (Burst: 27 m; 90 ft) 30 m (100 ft) (Burst: 40 m; 130 ft) 76 m (250 ft) (Burst: 107 m; 350 ft) 200 m (650 ft) (Burst: 229 m; 750 ft)	0.01% full scale	T63<1s, T90<1s, T95<1s	Pressure: psi, kPa, bar, mbar, inHg, mmHg Level: in, ft, mm, cm, m, cmH20, inH20	Piezoresistive; Ceramic

Warranty[14]

2 year - Sonde, RDO and sensor cap, temperature/conductivity, temperature only, turbidity (excluding pH/ORP)
1 year - pH/ORP, accessories
90 days - ISE Sensors; Other: see warranty policy (www.in-situ.com/warranty)

Notes

Specifications are subject to change without notice.

1) For 30 parameters >100,000 data records, > 3 years at 15 min. interval. A single data record includes timestamp, temperature, RDO, pH, ORP, turbidity and conductivity logged in Linear or Linear Average mode. 2) Log data recorded to SD card in comma delimited variable (CSV) file format. Greater than 32 GB not supported. 3) Logging all sensors at 15 min interval on 2 D Alkaline batteries. Battery life dependent on site conditions and wiping. 4) Dependent on display and wiping. 5) Sensor only, when transferring from air to ambient water temperature. Typical system response time with all sensors and restrictor: T63<30s, T90<3.5m, T95<7.5m. 6) Response time at thermal equilibrium. 7) Accuracy from calibration standard @ 25C, response-at thermal equilibrium immediately following calibration measuring from air to +400 mV. 8) Accuracy at calibration points. 9) RDO sensor full range 0-50mg/L, 0-500% sat. EPA-approved under the Alternate Test Procedure process. 10) User-defined reference. 11.) Between 2 calibration points immediately following proper conditioning and calibration. Varies on site conditions and environmental interferents. See sensor summary sheet for potential interferences. 12.) Average response; can be longer with increasing concentrations of ammonium. 13) Typical performance across full temperature and pressure calibrated range. 14) Extended warranty option for sonde only (1 to 3 year extension for up to 5 years total).

EPA RDO METHOD Approved EPA-Approved RDO Method

RoHS compliant CE FC

CALL OR CLICK TO PURCHASE OR RENT

1-800-446-7488 (toll-free in U.S.A. and Canada)
1-970-498-1500 (U.S.A. and international)

WWW.IN-SITU.COM

221 East Lincoln Avenue, Fort Collins, CO 80524 USA

In-Situ

Innovations in **Water Monitoring**

Spec Sheet

Level TROLL® 400, 500 & 700 Data Loggers

Get water level data the way you want it, when you want it with industry-leading water level/pressure and temperature data loggers. By partnering with In-Situ, you receive durable Level TROLL® Data Loggers that provide years of service, accurate results, intuitive software, and real-time functionality.

Be Effective

- **Increase productivity:** Reduce training and installation time with In-Situ intuitive software platform and integrated components. Patented twist-lock connectors, included on Level TROLL Loggers and RuggedCable® Systems, ensure error-free deployments.
- **Streamline analysis and reporting:** Automate water level corrections and post-processing, graph data, and accelerate report generation with Win-Situ® Software. Easily export data to Excel,® a web-based management service, or data analysis software.
- **Set up real-time networks:** Access data 24/7 and receive event notifications when you connect data loggers to Tube and Cube systems, radios, or other third-party data collection platforms. Get decision quality data when, where, and how you need it with HydroVu Data Services. Control gates, pumps, alarms, and other equipment by using built-in Modbus/RS485, SDI-12, or 4-20 mA communication protocols.

Be Reliable

- **Deploy in all environments:** Install loggers in fresh water, saltwater, and contaminated waters. Solid titanium and sealed construction outperforms and outlasts coated data loggers.
- **Log accurate data:** Get optimal accuracy under all operating conditions. Sensors undergo NIST®-traceable factory calibration across the full pressure and temperature range. For applications requiring the highest levels of accuracy, use a vented (gauged) system.
- **Get long-lasting operation:** Reduce trips to the field with low-power loggers that typically operate for 10 years.

Be In-Situ

- Receive **free**, 24/7 technical support and online resources.
- Order data loggers and accessories from the In-Situ website.
- Get guaranteed 7-day service for maintenance (U.S.A. only).

Applications

- **Aquifer characterization: slug tests & pumping tests**
- **Coastal: tide/harbor levels & wetland/estuary research**
- **Hydrologic events: crest stage gages, storm surge monitoring, & flood control systems**
- **Long-term, real-time groundwater & surface water monitoring**
- **Mining & remediation**

CALL OR CLICK TO PURCHASE OR RENT

1-800-446-7488 (toll-free in U.S.A. and Canada)
1-970-498-1500 (U.S.A. and international)

WWW.IN-SITU.COM

Level TROLL® 400, 500 & 700 Data Loggers

Spec Sheet

General	Level TROLL 400	Level TROLL 500	Level TROLL 700	Level BaroTROLL
Temperature ranges[1]	Operational: -20-80° C (-4-176° F) Storage: -40-80° C (-40-176° F) Calibrated: -5-50° C (23-122° F)	Operational: -20-80° C (-4-176° F) Storage: -40-80° C (-40-176° F) Calibrated: -5-50° C (23-122° F)	Operational: -20-80° C (-4-176° F) Storage: -40-80° C (-40-176° F) Calibrated: -5-50° C (23-122° F)	Operational: -20-80° C (-4-176° F) Storage: -40-80° C (-40-176° F) Calibrated: -5-50° C (23-122° F)
Diameter	1.83 cm (0.72 in.)	1.83 cm (0.72 in.)	1.83 cm (0.72 in.)	1.83 cm (0.72 in.)
Length	21.6 cm (8.5 in.)	21.6 cm (8.5 in.)	21.6 cm (8.5 in.)	21.6 cm (8.5 in.)
Weight	197 g (0.43 lb)	197 g (0.43 lb)	197 g (0.43 lb)	197 g (0.43 lb)
Materials	Titanium body; Delrin® nose cone	Titanium body; Delrin nose cone	Titanium body; Delrin nose cone	Titanium body; Delrin nose cone
Output options	Modbus/RS485, SDI-12, 4-20 mA	Modbus/RS485, SDI-12, 4-20 mA	Modbus/RS485, SDI-12, 4-20 mA	Modbus/RS485, SDI-12, 4-20 mA
Battery type & life[2]	3.6V lithium; 10 years or 2M readings	3.6V lithium; 10 years or 2M readings	3.6V lithium; 10 years or 2M readings	3.6V lithium; 10 years or 2M readings
External power	8-36 VDC	8-36 VDC	8-36 VDC	8-36 VDC
Memory *Data records*[3] *Data logs*	2.0 MB 130,000 50 logs	2.0 MB 130,000 50 logs	4.0 MB 260,000 50 logs	1.0 MB 65,000 2 logs
Fastest logging rate	2 per second	2 per second	4 per second	1 per minute
Fastest output rate	Modbus: 2 per second SDI-12 & 4-20 mA: 1 per second	Modbus: 2 per second SDI-12 & 4-20 mA: 1 per second	Modbus: 2 per second SDI-12 & 4-20 mA: 1 per second	Modbus: 2 per second SDI-12 & 4-20 mA: 1 per second
Log types	Linear, Fast Linear, and Event	Linear, Fast Linear, and Event	Linear, Fast Linear, Linear Average, Event, Step Linear, True Logarithmic	Linear
Sensor Type/Material	**Piezoresistive; titanium**	**Piezoresistive; titanium**	**Piezoresistive; titanium**	**Piezoresistive; titanium**
Range	Absolute (non-vented) 30 psia: 11 m (35 ft) 100 psia: 60 m (197 ft) 300 psia: 200 m (658 ft) 500 psia: 341 m (1120 ft)	Gauged (vented) 5 psig: 3.5 m (11.5 ft) 15 psig: 11 m (35 ft) 30 psig: 21 m (69 ft) 100 psig: 70 m (231 ft) 300 psig: 210 m (692 ft) 500 psig: 351 m (1153 ft)	Absolute (non-vented) 30 psia: 11 m (35 ft) 100 psia: 60 m (197 ft) 300 psia: 200 m (658 ft) 500 psia: 341 m (1120 ft) 1000 psia: 693 m (2273 ft) Gauged (vented) 5 psig: 3.5 m (11.5 ft) 15 psig: 11 m (35 ft) 30 psig: 21 m (69 ft) 100 psig: 70 m (231 ft) 300 psig: 210 m (692 ft) 500 psig: 351 m (1153 ft)	30 psia (usable up to 16.5 psi; 1.14 bar)
Accuracy[4]	±0.05% full scale (FS) at 15° C ±0.1% FS at 0 to 50° C	±0.05% FS at 15° C ±0.1% FS at 0 to 50° C	±0.05% FS at 15° C ±0.1% FS at 0 to 50° C	±0.05% FS at 15° C ±0.1% FS at 0 to 50° C
Resolution	±0.005% FS or better	±0.005% FS or better	±0.005% FS or better	±0.005% FS or better
Units of measure	Pressure: psi, kPa, bar, mbar, mmHg, inHg, cmH20, inH20 Level: in., ft, mm, cm, m	Pressure: psi, kPa, bar, mbar, mmHg, inHg, cmH20, inH20 Level: in., ft, mm, cm, m	Pressure: psi, kPa, bar, mbar, mmHg, inHg, cmH20, inH20 Level: in., ft, mm, cm, m	Pressure: psi, kPa, bar, mbar, mmHg, inHg, cmH20, inH20
Temperature Sensor	**Silicon**	**Silicon**	**Silicon**	**Silicon**
Accuracy	±0.1° C	±0.1° C	±0.1° C	±0.1° C
Resolution	0.01° C or better	0.01° C or better	0.01° C or better	0.01° C or better
Units of measure	Celsius or Fahrenheit	Celsius or Fahrenheit	Celsius or Fahrenheit	Celsius or Fahrenheit
Warranty	**3 years**	**3 years**	**3 years**	**3 years**
Notes	[1] Temperature range for non-freezing liquids. [2] Typical battery life when used within the factory-calibrated temperature range. [3] 1 data record = date/time plus 2 parameters logged (no wrapping) from device within the factory-calibrated temperature range. [4] Across factory-calibrated pressure range. [5] Across factory-calibrated pressure and temperature ranges. [6] Up to 5-year (total) extended warranties are available for all sensors—call for details. Delrin is a registered trademark of E.I. du Pont de Nemours and Company. Specifications are subject to change without notice.			

Every Application & Budget

Use maintenance-free, non-vented systems for long-term monitoring and at flood-prone or high-humidity sites. Pair with Tube and Cube Telemtry System and HydroVu for automtatic barometric compensation.

Use high-accuracy, vented systems to conduct aquifer tests and to view barometrically compensated water level data in real time.

Forgot to set a level reference at the beginning of a deployment? Automate level corrections by using Win-Situ Software's post-level correction Wizard.

BaroTROLL® Data Logger

When using a non-vented system, collect barometric pressure and temperature data with a titanium BaroTROLL Data Logger in order to post correct data for barometric pressure fluctuations.

Calculating barometric efficiency? Use the BaroTROLL Logger with vented systems.

CALL OR CLICK TO PURCHASE

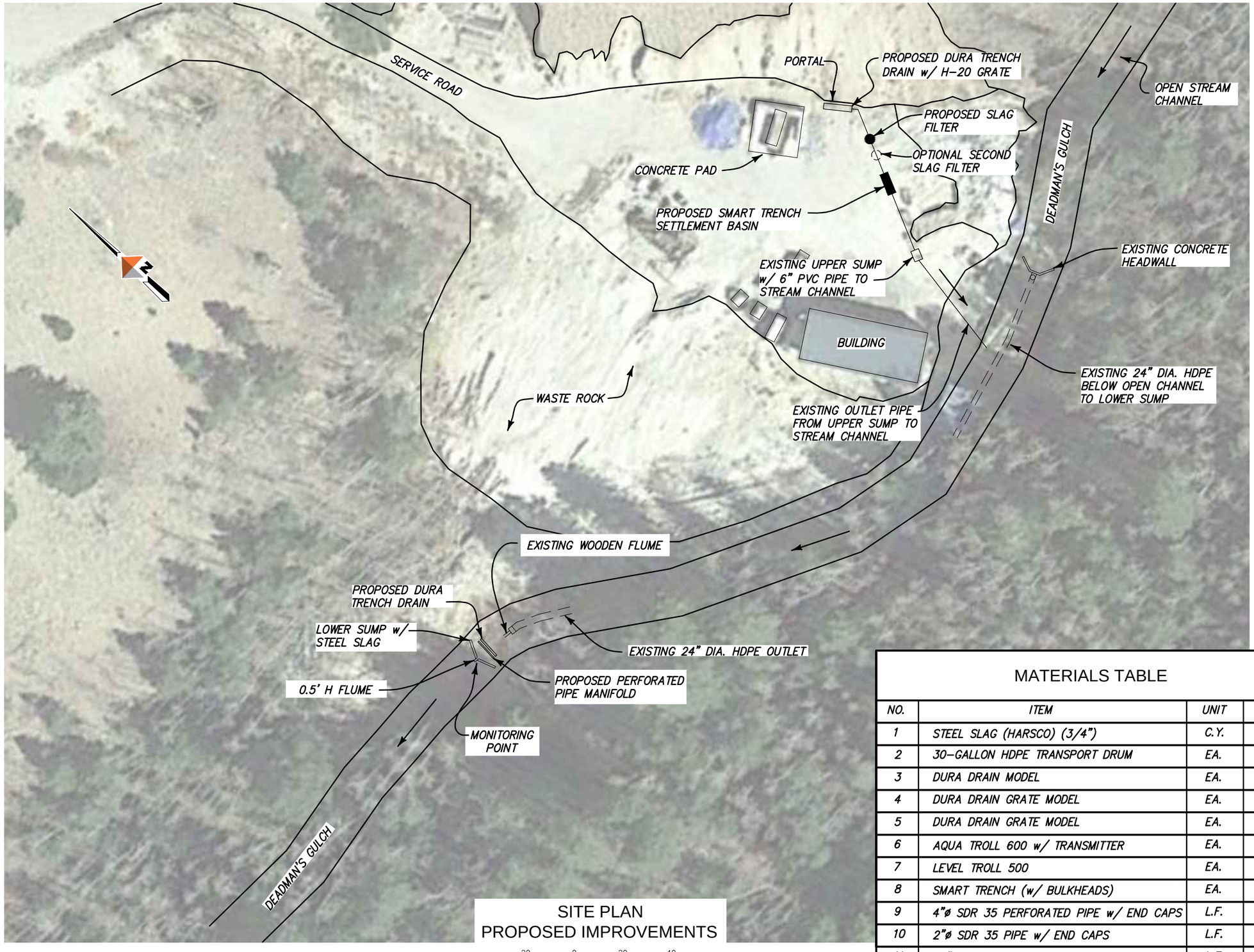
1-800-446-7488 (toll-free in U.S.A. and Canada)
1-970-498-1500 (U.S.A. and international)

WWW.IN-SITU.COM

221 East Lincoln Avenue, Fort Collins, CO 80524 USA

APPENDIX F

DESIGN PLANS



SITE PLAN
PROPOSED IMPROVEMENTS

20 0 20 40
SCALE IN FEET

MATERIALS TABLE

NO.	ITEM	UNIT	QUANTITY
1	STEEL SLAG (HARSCO) (3/4")	C.Y.	10
2	30-GALLON HDPE TRANSPORT DRUM	EA.	2
3	DURA DRAIN MODEL	EA.	5
4	DURA DRAIN GRATE MODEL	EA.	1
5	DURA DRAIN GRATE MODEL	EA.	4
6	AQUA TROLL 600 w/ TRANSMITTER	EA.	1
7	LEVEL TROLL 500	EA.	1
8	SMART TRENCH (w/ BULKHEADS)	EA.	1
9	4"ø SDR 35 PERFORATED PIPE w/ END CAPS	L.F.	16
10	2"ø SDR 35 PIPE w/ END CAPS	L.F.	100
11	36"ø CMP	L.F.	4

REVISIONS

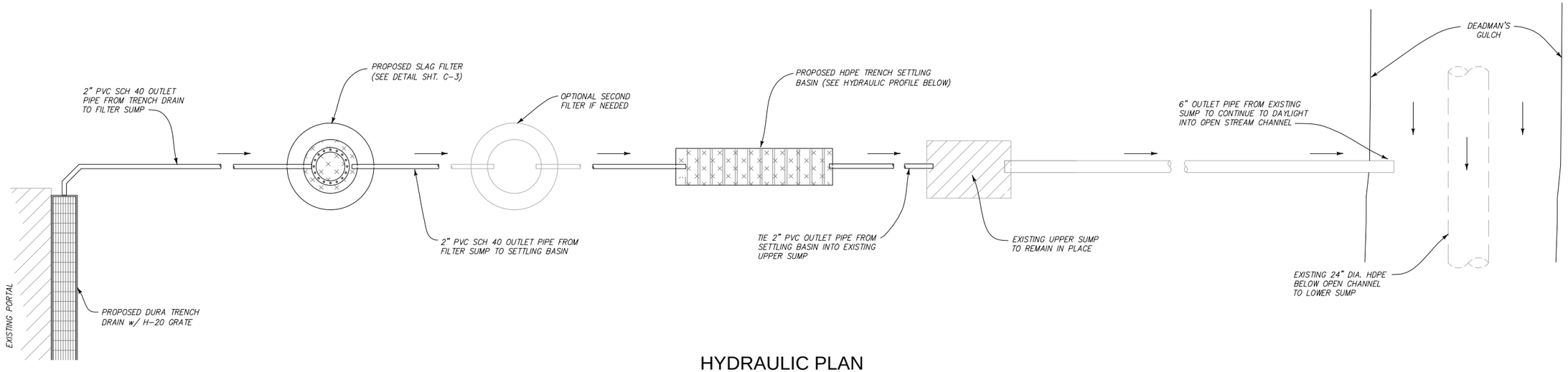
REV	DATE	DESCRIPTION	BY

DOWL
WWW.DOWL.COM
222 South Park Avenue
Montrose, Colorado 81401
970-249-6828

GOLDEN WONDER MINE
SITE PLAN
PROPOSED IMPROVEMENTS

PROJECT 7131.746.37.01
DATE 5/08/2017

SHEET
C-1
OF XX

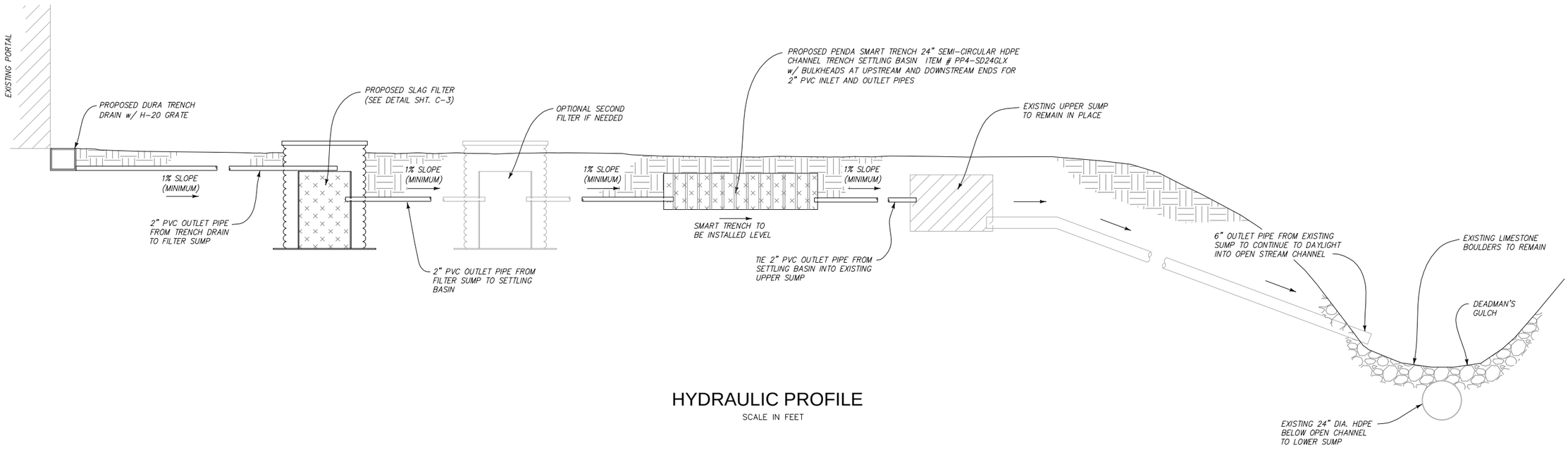


HYDRAULIC PLAN

SCALE IN FEET

NOTES :

1. ALL CONNECTING PIPE BETWEEN SYSTEM COMPONENTS TO BE 2 INCH DIAMETER SCHEDULE 40 PIPE UNLESS APPROVED BY OWNER AND ENGINEER



HYDRAULIC PROFILE

SCALE IN FEET

REVISIONS

REV	DATE	DESCRIPTION	BY

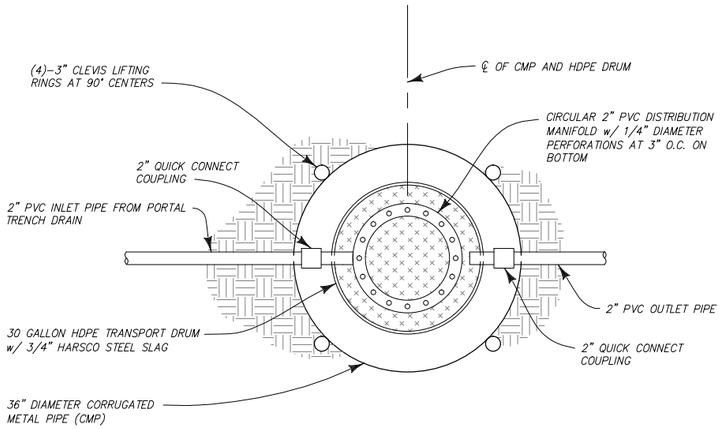
DOWL
WWW.DOWL.COM
222 South Park Avenue
Montrose, Colorado 81401
970-249-6828

GOLDEN WONDER MINE
PROPOSED IMPROVEMENTS
HYDRAULIC PLAN AND PROFILE

PROJECT 7131.74637.01
DATE 5/08/2017

SHEET
C-2
OF XX

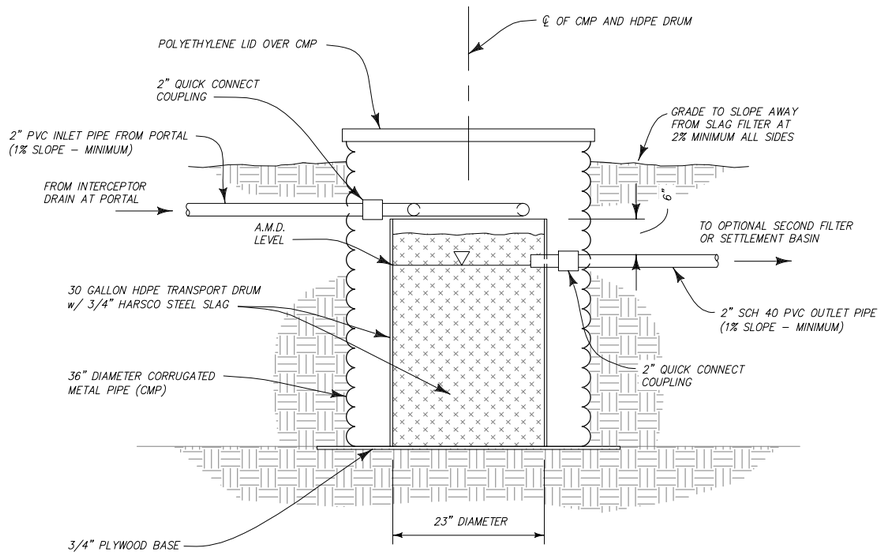
Q:\31\74637-01\65CAD\Golden Wonder Mine.dwg PLOT DATE 2017-5-7 14:34 SAVED DATE 2017-05-07 14:34 USER: jcarter



PLAN VIEW

SLAG FILTER DETAIL

NOT TO SCALE



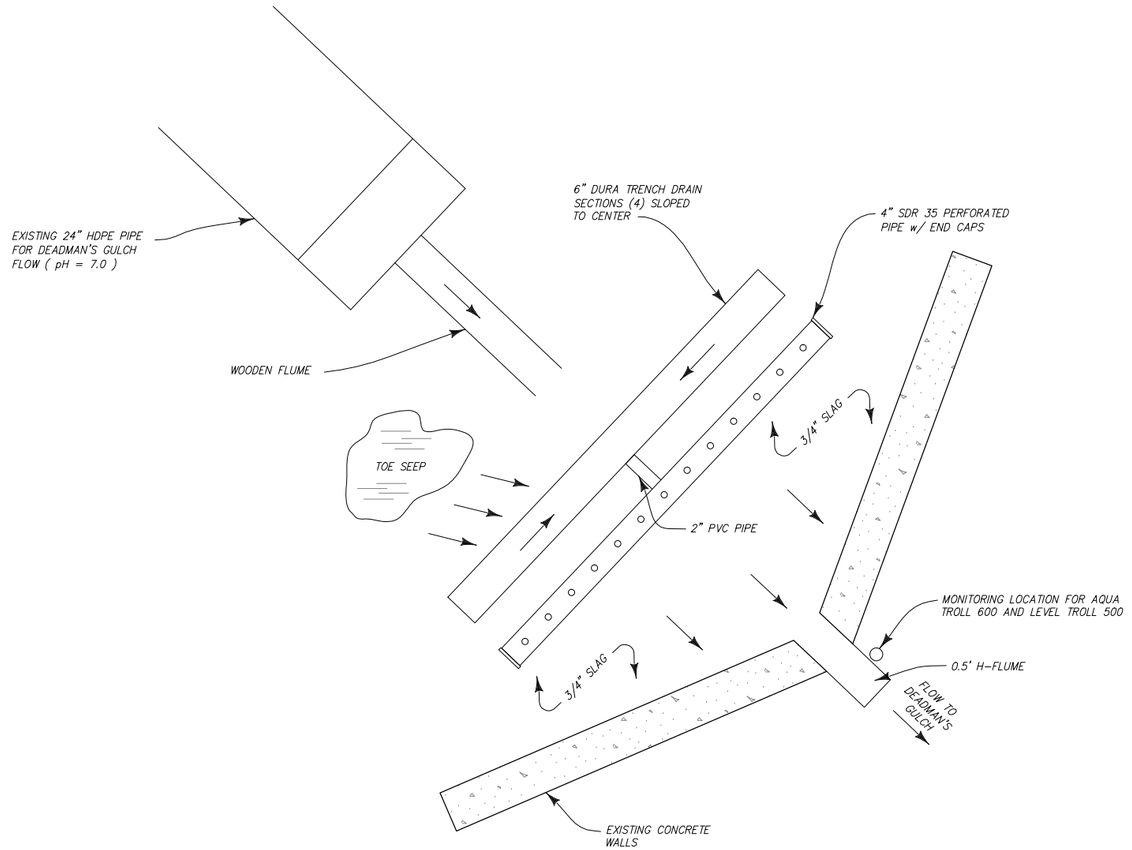
PROFILE VIEW

SLAG FILTER DETAIL

NOT TO SCALE

NOTES :

1. *30 GALLON HDPE TRANSPORT DRUM TO BE GRANGER ITEM #19H062 OR APPROVED EQUAL. CLOSED TOP TO BE REMOVED TO CREAT OPEN CONTAINER AS SHOWN.*



PLAN VIEW

SCHEMATIC LOWER SUMP DETAIL

NOT TO SCALE

NOTES :

1. *LOWER SUMP TO BE EMPTIED OF EXISTING CRUSHED LIMESTONE.*
2. *REPAIR / REPLACE EXISTING EPDM LINER AS NEEDED.*
3. *REPLACE LIMESTONE w/ 6 C.Y. OF HARSCO STEEL SLAG.*

REVISIONS		
REV	DATE	DESCRIPTION	BY

DOWL
WWW.DOWL.COM
222 South Park Avenue
Montrose, Colorado 81401
970-249-6828

GOLDEN WONDER MINE
SLAG FILTER AND
LOWER SUMP DETAILS

PROJECT 7131.74637.01
DATE 5/10/2017

SHEET
C-3
OF XX