Alaska Gold Company
A subsidiary of NovaGold Resources Inc.

APPLICATION FOR THE LAND DISPOSAL OF NON-DOMESTIC WASTEWATER AT THE ROCK CREEK PROJECT

Submitted To:

State of Alaska
Department of
Environmental
Conservation (ADEC)
Fairbanks, AK

Submitted By:

Alaska Gold Company
P.O. Box 640
Nome, Alaska 99762

Prepared By:

Tetra Tech, Inc.
350 Indiana Street,
Suite 500
Golden, CO 80401

May 12, 2010

Alaska Gold Company
A subsidiary of NovaGold Resources Inc.

May 20, 2010

VIA EMAIL

Mr. William McGee
Alaska Department of Environmental Conservation
Division of Water
610 University Avenue
Fairbanks, AK 99709-3643
Email: William.mcgee@alaska.gov

Re: Amendment to Application for the Land Disposal of Non-Domestic Wastewater at the Rock Creek Project

Dear Mr. McGee

This letter serves as an amendment to our land application permit application. NovaGold requests the ability to be able to use a third Land Shark unit with capacity up to 125 (gallons per minute) in addition to the 45 gpm and 125 gpm capacity units described in the original application. Use of all three units would be consistent with the operational controls described in the applications and any other requirements established in the permit.

Sincerely,

John Odden

John Odden
Production Manager, Nome Operations

Alaska Gold Company

P.O. Box 640, Nome, Alaska 99762-0640 USA
Telephone 907-443-5272 • Facsimile 907-443-5274

Head Office:
NovaGold Resources Inc.
Suite 2300, 200 Granville Street, Vancouver, BC Canada V6C 1S4
Telephone 604-669-6227 • Facsimile 604-669-6272 • www.novagold.net
Toronto Stock Exchange: NG • American Stock Exchange: NG

NovaGold
NOME OPERATIONS

April 9, 2010

Mr. Pete McGee
Department of Environmental Conservation
610 University Avenue
Fairbanks, AK 99709

Re: Application for the Land Disposal of Non-Domestic Wastewater at the Rock Creek Project.

Dear Mr. McGee:

Please find attached an application for the land disposal of non-domestic wastewater for to the A3 hillside area at the Rock Creek project. The source of the excess wastewater is from snowmelt, runoff, and groundwater collected in the mine's Tailings Storage Facility (TSF) and the Main and South sumps below the TSF. The proposed discharge would occur under the provisions outlined in 18 ACC 72.500 for the disposal of nondomestic wastewater. If accepted, the land application would only occur during the temporary closure period.

As you know, land application and aerial evaporation of wastewater from the Main and South sumps to the A3 area was conducted between September 23, 2009 and October 25, 2009 under COBC 2009-0748-50-8078. This application resulted in no adverse effects to the disposal area or the surrounding surface and ground water.

As discussed in Section 2.2 of the application, the water quality in both the TSF and the Main and South sumps is of good quality. Most parameters are consistently found in both the TSF and sump water and the monitoring wells at levels below the State's water quality standards. Water quality in the TSF has specifically improved over time since tailings disposal ceased at the end of 2008 and the approximately 100,000 tons of tailings have been flushed with fresh water inflows. During summer 2009, the TSF water quality was consistently better than the sump water quality because of the fresh water contained in the TSF. AGC anticipates that this will again occur during the 2010 summer/fall land application period. Water quality within the TSF and the sumps will continue to be monitored. Land application will be halted and the State will be notified should monitoring show an unexpected decline in the quality of these sources.

P.O. Box 640, Nome, Alaska 99762-0640 USA
Telephone 907-443-5272 • Facsimile 907-443-5274

Head Office:
NovaGold Resources Inc.
Suite 2300, 200 Granville Street, Vancouver, BC Canada V6C 1S4
Telephone 604-669-6227 • Facsimile 604-669-6272 • www.novagold.net
Toronto Stock Exchange: NG • American Stock Exchange: NG

Please feel free to call me if you have any questions regarding this submittal,

John Odden
Operations Manager, Nome Operations
NovaGold Resources

John Odden

Attachment

Cc: Jack DiMarchi, Large Mine Project Manager
Alaska Department of Natural Resources
Office of Project Management and Permitting
3700 Airport Way
Fairbanks, AK 99709-4609

Tim Pilon, Waste Management Permit
Alaska Department of Environmental Conservation
610 University Avenue
Fairbanks, AK 99709-3643

Allan Nakanishi, P.E.
Division of Wastewater
Alaska Department of Environmental Conservation
555 Cordova Street
Anchorage, AK 99501

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APPLICATION STATEMENT

This document is an application for a permit to dispose of nondomestic wastewater at the Rock Creek Project near Nome, Alaska using spray evaporators. The facility is owned and operated by the Alaska Gold Company (AGC). The source of the excess wastewater is from snowmelt, runoff, and groundwater collected in the mine's Paste Tailings Storage Facility (TSF) and the Main and South sumps below the TSF. The proposed discharge would occur under the provisions outlined in 18 ACC 72.500 for the disposal of nondomestic wastewater.

This document provides the following information, as specified under 18 ACC 72.600 (Application for Department Approval) to the greatest extent possible, as they apply to the proposed disposal.

- the location of proposed or existing improvements, wastewater treatment works and disposal systems, sewers, drinking water supply lines, drinking water sources, and waters in the vicinity;
- detailed flow diagrams showing the physical and chemical composition amount of each nondomestic wastewater disposal;
- statement of identifying persons who will own, operate, and maintain the proposed system;
- a description and timetable of the proposed construction or other activity;
- information on sludge handling and disposal from the proposed treatment works;
- other information the department requires to assess compliance.

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.

John Odden

John Odden
Facility Operations Manager
Alaska Gold Company, Nome Operations

5-12-10
Date

1.0 Background

The Rock Creek Mine/Mill Complex is located approximately 20 miles north of Nome Alaska in the Snake Creek Drainage (Figure 1). The mine consists of an inactive open-pit gold mine, two non-acid-generating development rock dumps, a gold recovery plant, and a paste tailings storage facility (TSF). The site layout is presented in Figure 2. The process plant site area includes a three-stage crushing and screening plant, a crushed ore stockpile, a mill facility, a maintenance shop, an administration and mine dry building, warehouse, explosive storage and fuel storage.

On September 4, 2009, Alaska Gold Company (AGC) submitted a proposal to the Alaska Department of Environmental Conservation (ADEC) to evaporate and land apply wastewater from the Main and South sumps to the A3 area using two evaporator-sprayer units. Figure 2 shows the location of the A3 area in relation to the layout of the mine. A3 is an approximate 10 acre area that is upslope from the TSF facility. The area is mostly bounded upslope by Diversion Channel 1 (DC1) and downslope by Diversion Channel 3 (DC3). This area is considered upland with typical tundra vegetation and is absent of jurisdictional wetlands. The 2009 proposal was based on the results and conclusions of a feasibility study which was conducted to evaluate the technical feasibility and effectiveness of land application of the wastewater. ADEC modified an existing Compliance Order by Consent No. 2009-0748-50-8078 (COBC) to allow the proposed land application to the A3 area under this order. As background to this application, the original feasibility study has been included as Attachment 1 of this application.

Land application and aerial evaporation of wastewater to the A3 area was conducted between September 23, 2009 and October 25, 2009 under COBC 2009-0748-50-8078. Land application disposal was concluded due to prevailing freezing temperatures and because application could not be conducted without accumulating snow on the ground, as was specified in Section 25.1.6 of the COBC. A report dated November 24, 2009 was prepared for ADEC that summarized the operations and results from the land application, as required by Section 25.1.14 of the CBOC. This operation did not result in any adverse effects to the environment.

This application has been prepared to evaporate land apply sump and TSF water under the provisions specified by 18 ACC 72.500, Disposal of Nondomestic Wastewater.

2.0 DESCRIPTION OF PROPOSED DISCHARGE

This section provides information regarding the proposed discharge of sump and TSF water, as specified under 18 ACC 72.600 (Application for Department Approval) to the greatest extent possible, as they apply to the proposed disposal.

2.1 Disposal Systems and Disposal Location

2.1.1 Description of Disposal System

Spray evaporator systems were identified and purchased for the approved 2009 land application described in Section 1. The land application was conducted using two Land Shark sprayer/evaporator units. These evaporator systems are manufactured by Western Pump and Dredge in Grand Junction, Colorado. According to the manufacturer, one Land Shark produces a spray rate of 45 gallons per minute (gpm) and the other larger unit produces a spray rate of 125 gpm. These units are either skid mounted and consist of a ring manifold of 30 spiral jet spray nozzles mounted in front of a powerful 30-inch diameter fan. The fan effectively atomizes the water spraying from the nozzles thereby creating a fine mist with a very small droplet size. The fan unit requires 460 volt, 3 phase electrical power and includes a NEMA 4x stainless steel control panel with 2 start/stop controls.

In application, the sprayer units were more efficient than anticipated at producing a very fine mist and achieving evaporation, even at relatively low temperatures (~40 °F). The spray from each unit dispersed over a larger area of ground than anticipated. This area of dispersion and the degree of evaporation generally became larger with increasing wind speed. Figure 3 shows a picture of one Land Shark in operation under an approximate wind speed of 10 to 20 miles per hour (mph) at approximately 40 °F. Figure 4 shows a picture of both Land Sharks operating from a distance; however, at the time of this photograph, the two units were only operating at a combined rate of 100 gpm. The spray/misting effect was greater when the two units were operating at a combined maximum output. The evaporation and land application of water that was conducted in the fall of 2009 did not result in any environmental impacts.

2.1.2 Disposal Location

The Land Sharks will be initially placed on a relatively flat bench approximately 2/3 up the A3 hillside (Figure 2). Each unit is capable of rotating the direction of the spray 360 degrees. The units will be rotated, as necessary, to adjust the spray angle according to the wind speed and direction, as well as the area of deposition of the spray. The units will be moved to different locations within the A3 hillside area as prescribed by the Best Management Practices (BMPs) described in Section 2.6, below.

The A3 area is mostly bounded upslope by DC1 and downslope by DC3. This area is considered upland with typical tundra vegetation and is absent of jurisdictional wetlands. The Glacier Creek drainage is approximately 0.2 miles to the south of the A3 area, and is

offsite of the mine (Figure 2). The proposed disposal will not occur in the vicinity of any sewer systems, drinking water supply lines, or drinking water sources.

2.2 Physical and Chemical Composition of the Wastewater

The water contained in the TSF and the Main and South sumps has been monitored for a full range of water quality parameters on at least a monthly basis for the past year. At the same time, background water quality data has been collected from wells throughout the site since 2004. The data in Tables 1, 2, and 3 show the most recent available results (February 17, 2010), as well as the historical minimum, maximum, and median data for several important parameters of interest.

Overall, most parameters are consistently found in both the TSF and sump water, and the wells at levels below the State's water quality standards. The exceptions are generally arsenic, antimony, manganese, and total dissolved solids (TDS), which are also observed in background data from groundwater monitoring wells. Weak acid dissociable (WAD) cyanide has only been observed once during that past year above the 5.2 micrograms per liter (µg/L) water quality standard (at 7.7 µg/L) in the Main sump in December 2008. All more recent data show WAD cyanide concentrations below the standard. In 2008, WAD cyanide was relatively high in the TSF with a maximum measured concentration of 59 µg/L. However, levels throughout 2009 dropped to low concentrations with only occasional exceedences of the water quality standard.

The applicable total arsenic standard is 10 µg/L. Arsenic values in the sump data generally range from 13 µg/L to 668 µg/L. However, one datum was reported at 4,130 µg/L for the Main sump in November of 2009. A review of the total recoverable data set, however, showed very high values for all metals, but normal or low concentrations for the dissolved phase metals. It is possible that the Main sump values recorded for that particular date are an anomaly of sampling, sampling equipment, or in the lab analysis. Most data collected from the sumps during the past 6 months have had arsenic levels below 100 µg/L. Arsenic is naturally occurring in both ground and surface water at the mine site. Background levels in wells vary significantly from sampling date to sampling date and location to location. However, levels are consistently observed in both shallow and deep wells from 50 to greater than 500 µg/L. The 95th percentile of arsenic levels in the MW-06 series of wells downgradient of the TSF is 134 µg/L. Similarly, in MW-03-05, which is also downgradient of the TSF and was monitored from 2004-2006, total arsenic levels ranged from 53.1 to 93.6 µg/L. Based on these data, AGC believes that the arsenic levels in the land applied TSF and sump water are consistent with background levels.

Antimony and manganese are typically found in TSF and sump water at levels above the standards of 6 and 50 µg/L, respectively. Antimony and manganese are also naturally occurring in surface and groundwater and concentrations vary significantly from location to location. During the past 6 months, total antimony concentrations in the sumps have ranged from approximately 7 to 35 µg/L. While background levels of antimony occasionally exceed the standard, they are generally less than 6 µg/L, particularly in the

wells below the TSF. The 95th percentile of antimony levels in the MW-06 series of wells is 1.4 µg/L.

During the past 6 months, total manganese concentrations in the sumps have ranged from approximately 50 to 500 µg/L, with the exception of the November 2009 sample, where manganese was reported at 4,570 µg/L. Manganese in the TSF has ranged ranged from 98 to 327 µg/L. While background levels in some wells frequently exceed the standard, the sump water typically has higher total manganese concentrations than the wells. The 95th percentile of manganese levels in the MW-06 series of wells downgradient of the TSF is 152.2 µg/L. This level, however, is heavily influenced by MW-06-9B where almost all manganese levels are above 175 mg/l; the levels in the other MW-06 wells are consistently below 50 µg/L.

TDS levels in the TSF and sump water sometimes exceed the standard of 500 milligrams per liter (mg/L), with reported levels up to 549 mg/L during the past year. In the monitoring wells, TDS levels are consistently below the standard. In the MW-06 series of wells, TDS levels have been below 330 mg/L during the past year and in MW-03-05, TDS concentrations were in the same range during 2004-2006.

Overall, AGC is not projecting that there will be significant adsorption or attenuation of water quality parameters through the land application process. Rather, we conservatively assume that water will either be evaporated or generally contained in the subsurface below the land application area. Shallow test wells that were installed to conduct hydrogeolgic characterization evaluations will be used to assess whether there is any lateral transport of water in the subsurface above the bedrock. If any discernible flow is observed in these wells, the mitigation measures described in this plan will be implemented. This should prevent any transport of associated water quality parameters in shallow groundwater. AGC recognizes that some of the land applied water could reach deeper, bedrock groundwater. However, we anticipate no impacts on downgradient wells beyond natural conditions. The wells downgradient of the TSF are also appropriate for monitoring the land application system. AGC and the State have developed a group of indicator parameters that allow for determination of whether there are changes from natural conditions in the monitoring wells. If the trigger levels for these parameters are exceeded, AGC will notify the State and propose any necessary corrective actions to address the TSF and land application system, as appropriate.

2.3 Responsible Persons

The Rock Creek Project is owned and operated by the Alaska Gold Company, a subsidiary of NovaGold Resources, Inc. The facility operations manager is John Odden. Shelley Hicks is the senior environmental coordinator for the facility, and the technical lead for operating the proposed evaporator units is Mr. Allan Taylor, the mill general foreman. Contact information is as follows:

Alaska Gold Company	PO Box 640 Nome, Alaska 99762-0640	
John Odden	Operations Manager	(907) 387-1124
Shelley Hicks	Senior Environmental Coordinator	(907) 387-1147
Allan Taylor	Mill General Foreman	(907) 387-1158

2.4 Disposal Timetable

Evaporative and land application disposal will be conducted primarily during the summer and fall season, or as long as field conditions are appropriate, as specified by the BMPs described in Section 2.6. Additionally, disposal will only occur during the shut down period. Only the Land Shark sprayer units will be used for the land application of wastewater and these units will only be operated with the blower fans running. Applications will be visually monitored at least once every four (4) hours. This requirement will allow for the sprayer units to be shut down should there be any equipment breakdown, broken water pipes or power outage to the blower fans. In order to maximize discharges of wastewater, spray operations may occur for up to 24-hours per day. The specified 4-hour equipment checks will continue during this period and that the operation will be stopped if any equipment malfunction is noted or any surface water runoff is noted.

The evaporative sprayers will be halted if surface runoff is observed and during heavy rain if it is determined that the spray evaporators could potentially add to ground saturation or runoff. Land application during freezing conditions will be conducted as long as the equipment is operational and appreciable accumulation of snow does not occur. The land application will be halted if observable snow accumulation does not melt and infiltrate within 24 hours.

2.5 Sludge Disposal

There is no sludge produced from the proposed discharge.

2.6 Other Information – Operational BMPs

Evaporative and land application disposal will be conducted using the following operational and conditional BMPs. These BMPs were developed based on the conclusions of the feasibility study (Attachment 1) and information gained during the previous land application conducted during 2009. Proposed BMPs are as follows:

- Only Land Shark sprayer units will be used for the land application of wastewater and these units will only be operated with the blower fans running. This requirement will ensure that any evaporative component of the application is maximized and that the misting of the spray is maximized. This requirement will also help prevent the development of subsurface saturated zones and flow initiating downgradient.

- The multiple Land Shark sprayer units will be located so the spray applications do not overlap on the surface of the ground. This requirement will ensure that the application rate stays well below a rate that could promote surface runoff.
- Applications will be visually monitored at least once every four (4) hours. This requirement will allow for the sprayer units to be shut down should there be any equipment breakdown, broken water pipes or power outage to the blower fans. This BMP helps ensure that uncontrolled runoff or discharge from broken equipment or a broken pipe, etc. does not flow unchecked to the ditches or area streams. A record will be kept and initialed each four-hour period by an employee with any comments noted regarding the piping, pumps, sprayers, and blower fans. This record will be made available to ADEC upon request.
- Land application during freezing conditions is allowed as long as the equipment is operational and appreciable accumulation of snow does not occur. The land application must be halted if observable snow accumulation does not melt and infiltrate within 24 hours.
- AGC will develop operating procedures to safely drain piping and the sprayer units if there is potential for freezing temperatures to cause spills or to damage the equipment.
- Applications will be halted if surface runoff is observed and during heavy rain if it is determined that the spray evaporators could potentially add to ground saturation or runoff.
- The direction of the sprayer units will be rotated at a minimum of every three days. This requirement will allow application areas to be effectively utilized and help prevent subsurface saturated zones of significant length from developing down-gradient.
- The application will be halted should any ponding or spongy soaked ground occur on the surface or if surface runoff is noted during the 4-hour equipment inspections. The direction of the sprayer unit(s) will be rotated or the sprayer units will be relocated to a different area on the A3 hillside should these conditions occur.
- Field observations have shown that some historic ditches occur along the A3 hillside in addition to the DC3 diversion. These ditches and the DC3 diversion ditch will be inspected once each day of operation to look for visual signs of seepage along the ditch walls. If seepage is noted, the application will be stopped and the sprayer unit(s) will be moved and rotated to a different area. If seepage along a ditch wall continues for more than 3 days, the application will be stopped until the seepage stops. This requirement will indicate if the subsurface has become saturated and significant groundwater flow is developing down-gradient. AGC will keep a record of all ditch inspections and take photographs of any noted seepage. These records will be made available to ADEC upon request.
- Three test wells were installed during the feasibility study as part of the hydrogeologic characterization of the hillside area. These wells are normally dry,

but will be monitored every 2 days to determine if a water table is developing. These wells are located at the toe of the slope and will indicate if groundwater flow is developing down-gradient and could potentially flow off the A3 area. If a groundwater table is encountered in these test wells, the land application will be stopped and ADEC notified. AGC will keep a record of all well inspections. These records will be made available to ADEC upon request.

Tables

Table 1. Water Quality Results for the TSF

	Parameter						
	Antimony µg/L (Total)	Arsenic µg/L (Total)	Cyanide (WAD) µg/L	Lead µg/L (Dissolved)	Manganese µg/L (Total)	Mercury ng/L	TDS mg/L
February 17, 2010	8.75	19.8	< 1.5	< 0.062	223	< 0.5	475
Minimum	0.44	6.4	< 1.5	< 0.062	98.2	< 0.5	255
Maximum	18.8	64.4	59	0.373	327	3.9	549
Median	8.115	44.7	14.5	< 0.062	281	1.29	439

[1] Most Recent Available Sample Result
µg/L = micrograms per liter; mg/L = milligrams per liter; ng/L = nanograms per liter

Table 2. Water Quality Results for the South Sump

	Parameter						
	Antimony µg/L (Total)	Arsenic µg/L (Total)	Cyanide (WAD) µg/L	Lead µg/L (Dissolved)	Manganese µg/L (Total)	Mercury ng/L	TDS mg/L
February 17, 2010	8.97	425	< 1.5	0.09	343	22.6	473
Minimum	7.95	28.2	< 1.5	< 0.062	35.4	< 0.5	241
Maximum	38	425	4.4	0.222	343	22.6	533
Median	12.8	68.35	< 1.5	< 0.062	66.85	0.85	413

[1] Most Recent Available Sample Result
µg/L = micrograms per liter; mg/L = milligrams per liter; ng/L = nanograms per liter

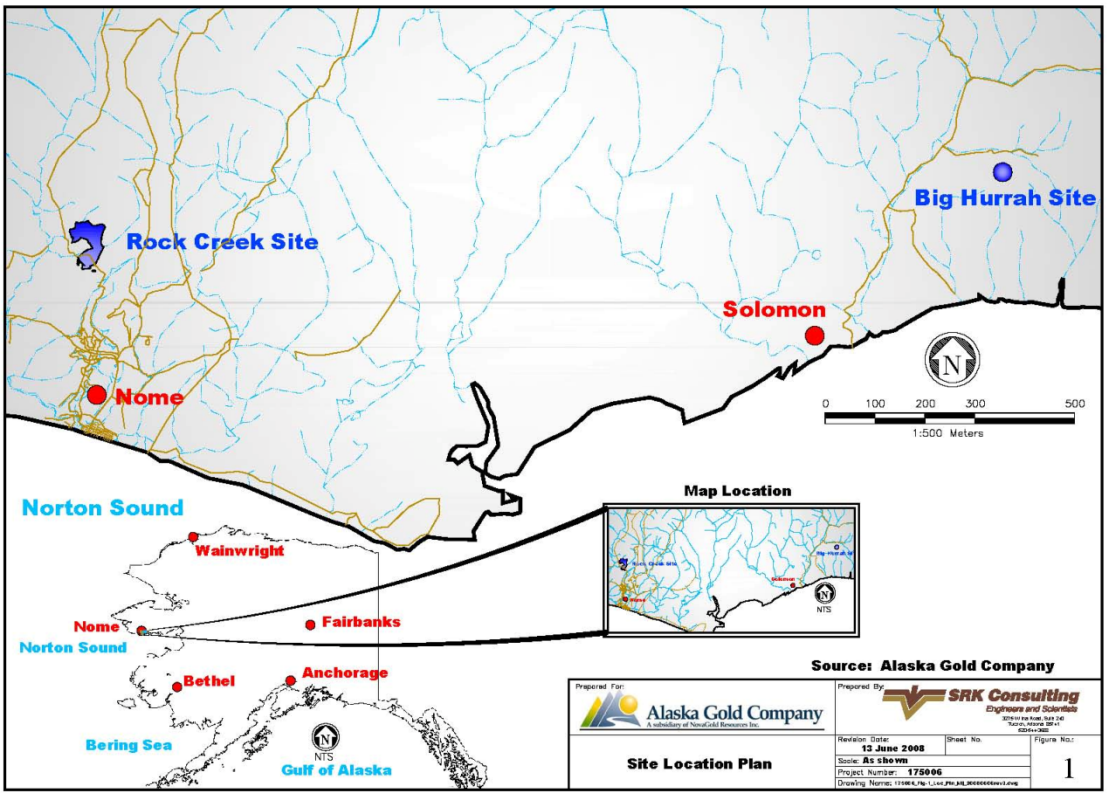
Table 3. Water Quality Results for the Main Sump

	Parameter						
	Antimony µg/L (Total)	Arsenic µg/L (Total)	Cyanide (WAD) µg/L	Lead µg/L (Dissolved)	Manganese µg/L (Total)	Mercury ng/L	TDS mg/L
February 17, 2010	8.1	581	< 1.5	< 0.062	704	7.28	518
Minimum	6	27.6	< 1.5	< 0.062	45.6	< 0.5	300
Maximum	34.9	4,130	7.7	0.445	4,570	12.1	536
Median	10.8	50.8	< 1.5	< 0.062	206	1.58	464

[1] Most Recent Available Sample Result

µg/L = micrograms per liter; mg/L = milligrams per liter; ng/L = nanograms per liter

Figures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Map Location
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Fairbanks
Bethel
Anchorage
Bering Sea
Gulf of Alaska
Source: Alaska Gold Company
Prepared For:
Alaska Gold Company
Prepared By:
SRK Consulting
Engineers and Scientists
Site Location Plan
Revision Date: 13 June 2008
Sheet No.
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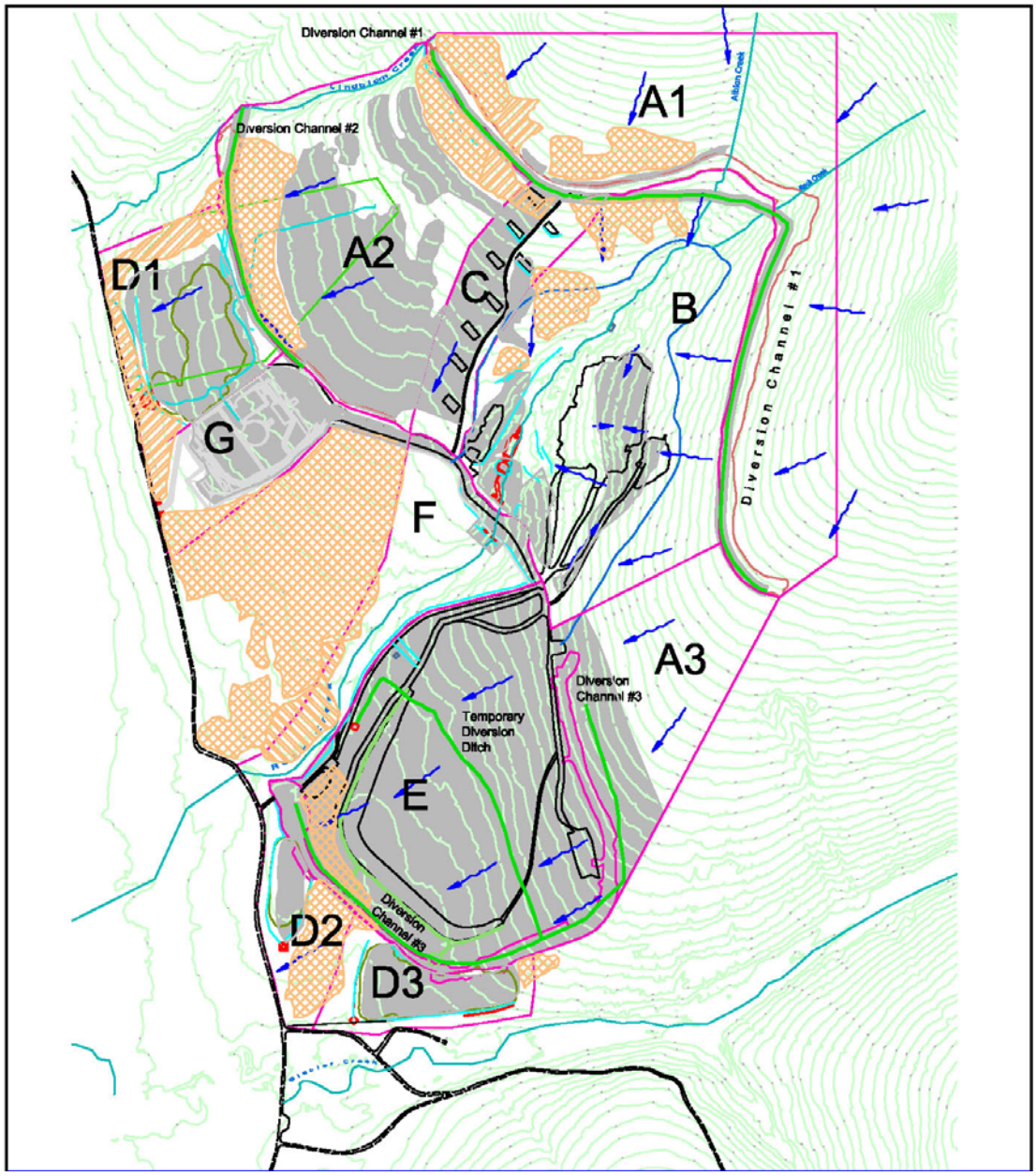
Project Number: 175006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D3

Figure 3. Land Shark unit in operation viewed from an uphill location on the A3 area. The date stamp on the photograph mistakenly says 2008 instead of 2009 because the date in the camera was set improperly.

Figure 4. Both Land Shark units operating as viewed from the mine access road. The date stamp on the photograph mistakenly says 2008 instead of 2009 because the date in the camera was set improperly.

Attachment 1

Results of Feasibility Study for the Land Application of Wastewater at the Rock Creek Project

RESULTS OF FEASIBILITY STUDY FOR THE LAND APPLICATION OF WASTEWATER AT THE ROCK CREEK PROJECT

AND

APPLICATION FOR LAND APPLICATION DISPOSAL

Prepared for:

State of Alaska
Department of Environmental Conservation (ADEC)
Fairbanks, AK

Prepared by:

Tetra Tech, Inc.
350 Indiana St., Suite 500
Golden CO, 80401

NovaGold Resources, Inc.
Rock Creek Project
Nome, AK

September 2, 2009

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Attachment 1: Detailed Results for Test Wells

Attachment 2: Detailed Results for Infiltration Tests

1.0 INTRODUCTION

The Rock Creek Mine/Mill Complex consists of an inactive open-pit gold mine, two non-acid-generating development rock dumps, a gold recovery plant, and a paste tailings storage facility (TSF). The site layout is presented in Figure 1. The process plant site area includes a three-stage crushing and screening plant, a crushed ore stockpile, a mill facility, a maintenance shop, an administration and mine dry building, warehouse, explosive storage and fuel storage.

On August 10, 2009, NovaGold Resources, Inc. (NovaGold) submitted a study plan to evaluate the feasibility of applying and infiltrating excess wastewater via land application to area A3 (as designated on Figure 1) to the Alaska Department of Environmental Conservation (ADEC)[1]. The source of the excess wastewater is from snowmelt, runoff, and groundwater collected in the TSF and the Main and South sumps below the TSF. A3 is an approximate 10 acre area that is upslope from the TSF facility. The area is mostly bounded upslope by Diversion Channel 1 (DC1) and downslope by Diversion Channel 3 (DC3). This area is considered upland with typical tundra vegetation and is absent of jurisdictional wetlands. A letter was received on August 12, 2009 approving the Feasibility Study plan.[2]

This document presents the results of the proposed feasibility tests and an application to utilize land application for the partial disposal of these waters. The application for disposal includes a list of operating and observational Best Management Practices (BMPs) under which land application would take place. These BMPs have been developed based on the results of the feasibility study to prevent (1) runoff of wastewater or aerial drift to Glacier Creek and other streams, and (2) groundwater flow to DC3 ditches or the TSF.

[1] NovaGold. 2009. *Feasibility Study for the Land Application of Wastewater at the Rock Creek Project. August 10, 2009. Tetratech.*

[2] ADEC. 2009. Letter from William McGee (ADEC) to David Jarvis (NovaGold). File No. 400.62.001. August 12, 2009.

2.0 BACKGROUND

2.1 Site Geology and Soils

The Seward Peninsula is underlain by bedrock belonging to the Nome Group. The parent rock of this group consists of shales, siltstones, marls, and limestone deposited in a shallow water continental shelf setting. Carbonaceous schist, calc schist, and mixed schist are closest to the surface, with carbonaceous schist present in the stream valley with mixed schist to the east and calc schist generally to the west.

The Nome soils are a combination of two types of Histic Pergelic Cryaquepts with loamy or gravelly textures. The soils occur above a shallow to moderately deep permafrost table depending on location. The soils formed in moderately deep loamy sediment are underlain by very gravelly and stony material. The soils are formed in alluvial material and support tundra vegetation (USDA, SCS, 1979). The Exploratory Soil Survey of Alaska (1979) indicates the Rock Creek Mine/Mill Complex site as being in the highland area of the Seward Peninsula. Topsoil depths at the Rock Creek mine were previously measured at nine sites. Topsoil depths ranged from 1 to 6 inches with a mean value of 3.5 inches. Topsoils overlay subsoils which vary in depth and vary in depth above the permafrost table. The surface zone of the permafrost horizon termed the "active layer" repeatedly thaws and freezes on an annual basis as the seasonal air temperatures changes. This zone is estimated to be approximately 6.5 to 10 feet. Soils within the proposed application area have been described as consisting of a thin tundra mat approximately 8 inches thick overlying sandy silt to fine silty-sand. Depth to bedrock is approximately 4 to 8 feet. Little water was observed in test pits that were evaluated as part of a geotechnical study for mine facility planning.

2.2 Water Quality of the Main and South Sumps and TSF

The water contained in the Main and South sumps has been monitored for a full range of water quality parameters on at least a monthly basis for the past year. At the same time, background water quality data has been collected from wells throughout the site since 2004. Overall, most parameters are consistently found in both the sump water and the wells at levels below the State's water quality standards. The exceptions are generally arsenic, antimony, manganese, and total dissolved solids (TDS), which are also observed in background data from groundwater monitoring wells. Note that weak acid dissociable (WAD) cyanide has only been observed once during that past year above 5.2 micrograms per liter (µg/L) (at 7.7 µg/L) in the Main Sump in December 2008. All more recent data show WAD cyanide concentrations below the standard.

The applicable total arsenic standard is 10 µg/L. Arsenic values in the sump data range from 13 µg/L to 668 µg/L. All data collected from the sumps during the past 6 months have had arsenic levels below 100 µg/L. Arsenic is naturally occurring in both ground and surface water at the mine site. Background levels in wells vary significantly from sampling date to sampling date and location to location. However, levels are consistently observed in both shallow and deep wells from 50 to greater than 500 µg/L. The 95th percentile of arsenic levels in the MW-06 series of wells downgradient of the TSF is 134

µg/L. Similarly, in MW-03-05, which is also downgradient of the TSF and was monitored from 2004-2006, total arsenic levels ranged from 53.1 to 93.6 µg/L. Based on these data, NovaGold believes that the arsenic levels in the land applied sump water are consistent with background levels.

Antimony and manganese are typically found in sump water at levels above the standards of 6 and 50 µg/L, respectively. Antimony and manganese are also naturally occurring in surface and groundwater and concentrations vary significantly from location to location. During the past 6 months, total antimony concentrations in the sumps have ranged from approximately 7 to 20 µg/L. While background levels of antimony occasionally exceed the standard, they are generally less than 6 µg/L, particularly in the wells below the TSF. The 95th percentile of antimony levels in the MW-06 series of wells is 1.4 µg/L. During the past 6 months, total manganese concentrations in the sumps have ranged from approximately 50 to 500 µg/L. While background levels in some wells frequently exceed the standard, the sump water typically has higher total manganese concentrations than the wells. The 95th percentile of manganese levels in the MW-06 series of wells downgradient of the TSF is 152.2 µg/L. This level, however, is heavily influenced by MW-06-9B where almost all manganese levels are above 175 mg/l; the levels in the other MW-06 wells are consistently below 50 µg/L.

TDS levels in the sump water sometimes exceed the standard of 500 milligrams per liter (mg/L), with reported levels up to 536 mg/L during the past year. In the monitoring wells, TDS levels are consistently below the standard. In the MW-06 series of wells, TDS levels have been below 330 mg/L during the past year and in MW-03-05, TDS concentrations were in the same range during 2004-2006.

In the past, metals and TDS levels in the TSF water have been consistent with or higher than the sump water. In addition, WAD cyanide had been observed in the TSF above the standard of 5 µg/L. More recent data, however, show TSF water quality improving to equivalent to or better than the sump water with cyanide levels consistently below 5 µg/L.

Overall, NovaGold is not projecting that there will be significant adsorption or attenuation of water quality parameters through the land application process. Rather, we conservatively assume that water will either be evaporated or generally contained in the subsurface below the land application area. As described later in this document (Section 5.0), the shallow test wells that were installed to conduct hydrogeolgic characterization evaluations will be used to assess whether there is any lateral transport of water in the subsurface above the bedrock. If any discernible flow is observed in these wells, the mitigation measures described in this plan will be implemented. This should prevent any transport of associated water quality parameters in shallow groundwater. NovaGold recognizes that some of the land applied water could reach deeper, bedrock groundwater. However, we anticipate no impacts on downgradient wells beyond natural conditions. The wells downgradient of the TSF are also appropriate for monitoring the land application system. NovaGold and the State have developed a group of indicator parameters that allow for determination of whether there are changes from natural conditions in the monitoring wells. If the trigger levels for these parameters are

exceeded, NovaGold will notify the State and propose any necessary corrective actions to address the TSF and land application system, as appropriate.

3.0 RESULTS OF FEASIBILITY STUDY

Several field tests were used to evaluate the technical feasibility of land application disposal. The tests were designed to assess the long term saturated infiltration rate through the surface soils and the hydrogeologic properties of subsoils located below the surface. The feasibility study did not include an evaluation of column leach tests to study the loading of contaminants and soil adsorption or attenuation (see previous discussion of water quality). The study was designed to supply the following information.

- Description of soil profiles, soil horizons and approximate depths below the ground surface
- Assessment and extent of permafrost if it exists
- Depth to water table
- Depths and aerial extent of all subsurface layers to be used for disposal
- Hydraulic conductivity and transmissivity of the subsurface layers
- Hydraulic conductivity and infiltration capacity through surface layers
- Acceptable application rates

A summary of the tests and methods used for the feasibility study are provided in this report. However, a more detailed description of the specific tests and methods used for the feasibility study was presented in the August 10, 2009 feasibility study plan.

3.1 Soil and Subsoil Profiles

Three test pits were excavated for evaluation of soil and subsoil profiles. The pits were excavated and evaluated by a civil engineer and reviewed by a hydrologist from Tetra Tech. The following information was recorded:

- Description of surface and subsurface soil horizons and their depths
- Description of the approximate texture for each identified soil and subsoil horizon
- Type of structure of the B horizon if a noticeable structure is discernable (the B horizon is usually the first layer of subsoil that is immediately below the top-soil A horizon).
- Description of surface vegetation and approximate root depths
- Depth to groundwater table if a discernable groundwater table is encountered

3.1.1 Soil Test Pit #1

The first test pit was located in the north corner of area A3 below DC1. A photograph of this profile is shown in Figure 2-1. The vegetation of this pit is a typical thick tundra mat consisting of low-growing grasses, berries and mosses with roots penetrating the soil profile eight to 10 inches. Distinct soil horizons are not discernable and the profile has a

slight blocky to platy structure. The soil of the main profile below the surface was approximately 2 feet deep and has a loamy texture consisting of silty-sands with some gravels and clays. Below this profile, the subsoil is a mixture of cobbles, gravel and some silty-sand down to bedrock. Generally, the larger cobbles are towards the bottom of the subsoil. The total depth to a lithic contact (e.g., hard barrier), presumed to be weathered bedrock, was approximately 3.5 feet. No water table or permafrost zones were encountered.

3.1.2 Soil Test Pit #2

The second test pit was located in the northeast corner of area A3 immediately below, and near the upstream end of DC1. A photograph of this profile is shown in Figure 2-2. This soil profile is very similar to Test Pit #1. The vegetation of this pit is a typical thick tundra mat consisting of low-growing grasses and mosses with roots penetrating the soil profile eight to 10 inches. Distinct soil horizons are weakly developed to non-discernable with a slight blocky to platy structure. The soil of the main profile below the surface was approximately 1.5 feet deep with a loamy texture consisting of silty-sands with some gravels and clays. Below this profile, the subsoil is a mixture of larger rock, cobbles, gravel and some silty-sand down to bedrock. Generally, the larger cobbles and rock are towards the bottom of the subsoil. The total depth to a lithic contact (e.g., hard barrier), presumed to be weathered bedrock, was approximately 3.0 feet. No water table or permafrost zones were encountered.

3.1.3 Soil Test Pit #3

The third test pit was located in the south to southeast corner of area A3 immediately above the thickener plant and DC3. A photograph of this profile is shown in Figure 2-3. Similar to the other test pit sites, the vegetation of this pit is a typical thick tundra mat consisting of low-growing grasses, berries and mosses with roots penetrating the soil profile eight to 10 inches. Distinct soil horizons below the surface were not discernable. The soil of the main profile below the surface was approximately 3.5 to 4.0 feet deep with a loamy texture consisting of silty-sands with a high degree of mixed gravels and cobbles. Below this profile, the subsoil is a mixture of larger rock, cobbles, gravel and some silty-sand down to bedrock. Generally, the larger cobbles and rock are towards the bottom of the subsoil. The total depth to a lithic contact (e.g., hard barrier), presumed to be weathered bedrock was approximately 6.0 feet. No water table or permafrost zones were encountered.

3.1.4 Evaluation of Soil Pits

The encountered soil profiles are typical of cryaquepts (geologically new soils of cold wet regions). There are several positive aspects of these soil profiles with respect to infiltration and storage of water.

- The lack of strong horizonation of the soil profile is relatively conducive to the infiltration and drainage of water. This is because “older” more highly developed soils with strong degrees of horizonation can have distinct layers, some of which

have relatively high clay contents which tend to inhibit infiltration and drainage to subsoil layers. While some clay does exist in these profiles, the soils appear to have a loamy texture that is a mixture of clays, sands, silts, and gravels.

- The dense vegetation cover at the surface will resist any erosion or entrainment of soils by "rain drop impact" and interrill erosion. The density of stems and grasses will promote interception of water (on the vegetation itself) and inhibit the development of rills and the surface transport of water. These vegetation properties essentially promote infiltration into the subsurface. The deep penetrating root structure also provides conduits for water transport to the subsurface.
- While the dominating texture is a loamy soil, consisting of sands, silts, and some clays, the high degree of gravels and cobbles, particularly in the lower profile, should promote drainage to lower zones. However, the loamy, relatively fine texture suggests that the porosity (pore volume) of these soils may be moderately high. Finer soils, such as fine silts and clays can have porosities (pore volumes) exceeding 50 to 60 percent, while fine sands may have porosities of 40 to 50 percent. This phenomenon is a function of the large surface area of fine particles creating a high volume of pore space. A conservative assumption of the effective porosity of the soils observed in these profiles is 40 percent. It is important to note that the pore space is not necessarily related to the ability for a soil or any hydrostratigraphic medium to transport water.

3.2 Hydrogeologic Characterization of the Subsoils

Three shallow groundwater test wells were installed to characterize the hydrogeologic conditions of the lower soil profile. The wells were installed in the lower slopes of the proposed land application area above DC3. The wells ranged in depth from 4 feet to 8 feet and went down to bedrock. The screened intervals were in the deeper subsoils and cobbles ranging from 3 feet to 5 feet in length. The depths of the wells and the screening intervals were determined based on the descriptions of the vertical soil and subsoil profiles obtained in the test pits. The wells were constructed following procedures consistent with those suggested by ADEC for the installation of more formal monitoring wells.[3] The annulus of the well were filled with a sand pack and capped with a bentonite seal and left over night to allow the bentonite to hydrate and setup.

Falling head (slug) tests were used to measure the hydraulic conductivity (K) of the aquifer in the screened zone (i.e., the subsoil profile). K can be loosely defined as a measure of the ease with which water can be transmitted through a porous material. More specifically, K is the velocity with units of length/time that water would transport across a saturated porous medium under a unit gradient of 1 (e.g., height to length). The falling head procedure involves rapidly adding a measured quantity of water to the well, followed by making a rapid series of water-level measurements to assess the rate of

[3] *Monitoring Well Guidance*. 2009. Alaska Department of Environmental Conservation, Division of Spill Prevention Response Contaminated Sites Program.

water-level drop. K was determined by averaging the two different calculation methods of Bouwer and Rice (1976)[4] and Hvorslev (1951).[5]

3.2.1 Results of Falling Head Tests

Detailed results from the falling head tests are provided in Attachment 1. The hydraulic conductivity calculated from the falling head tests in the three test wells are shown in Table 2-1 below:

Table 2-1. Results of falling head hydraulic conductivity tests on three test wells

Test Well	Average K (cm/sec)	Average K (ft/day)
TW-1	7.06×10^{-5}	0.20
TW-2	3.03×10^{-3}	8.58
TW-3	4.07×10^{-3}	11.5
Three-well Average	2.39×10^{-3}	6.76

cm/sec = centimeters per second
ft/day = feet per day

3.2.2 Evaluation of Well Tests

These data suggest a moderately permeable medium that is similar to what would occur in a loam soil or fine sand. As a comparison, Table 2-2 shows commonly measured K values for a variety of soil mediums:

Table 2-2. Range for K of various porous materials

Porous Material	Average K (ft/day)
Clay soils	0.03 – 0.66
Loam soils	0.3 – 3
Fine sand	3 - 15
Medium sand	15 - 70
Fractured Bedrock	3 - 1000
Gravels	330 – 3,500

ft/day = feet per day

There are two aspects of these data with respect to infiltration and storage of water:

- The K values confirm soil profile information suggesting that the soils of this area are conducive to the infiltration and drainage of water. As previously discussed, "older" more highly developed soils with strong degrees of horizonation can have

[4] Bouwer, H. and R.C. Rice, 1976. A slug test method for determining hydraulic conductivity of unconfined aquifers with completely or partially penetrating wells, Water Resources Research, vol. 12, no. 3, pp. 423-428.

[5] Hvorslev, M.J., 1951. *Time Lag and Soil Permeability in Ground-Water Observations*, Bull. No. 36, Waterways Exper. Sta. Corps of Engrs, U.S. Army, Vicksburg, Mississippi, pp. 1-50.

distinct layers which are relatively high in clays that tend to inhibit vertical infiltration and drainage to subsoil layers. These data suggest that the soils in the profile will not inhibit infiltration and drainage. The silty-sands seem to dominate the hydraulic and hydrogeologic flow properties below the surface with only some moderate influence by the coarser gravels and cobbles.

- The moderate K values measured for the subsoil medium show that there is only a moderate potential for the flow of water through the subsurface downgradient. These conditions could only develop if a continuously saturated zone with sustainable head (gradient) were allowed to develop. The exact velocity and transport capacity would depend on the steepness of the gradient and the length of any continuous saturated zone. It should be noted that the soils in the A3 area are only partially saturated and are not under a continuous groundwater flow condition of constant head and source. While the moderate permeability of these soils is conducive to infiltration, they will be slightly inhibitive to a large flux of groundwater flow if saturation of the subsurface is not allowed to develop for a considerable length in the downgradient direction. These data suggest that a land application system should be rotated around the landscape within the A3 area to prevent a large continuous length downgradient to become overly saturated.

3.3 Small-scale Infiltration Test

The tests conducted to determine the hydraulic and flow properties of the subsurface described in Section 3.2 above do not directly imply the rate at which water can infiltrate through the surface into the subsurface. This is because the infiltration capacity of soils at the surface are affected by the degree of vegetation, potential thin surface crusts that can form on soil, and the degree and density of roots which can act as conduits for water to be transported vertically into the soils.

For this reason, two test plots were used to evaluate the infiltration rates and capacity of the water through the surface. The first test plot was located in the north corner of area A3 below DC1 near Test Pit #1. The second test plot was located in the northeast corner of area A3 immediately below, and near the upstream end of DC1 and near Test Pit #2. Each test plot of approximately 100 square feet was enclosed with excavated berms. The berms were covered with plastic to prevent horizontal seepage and promote the vertical infiltration of water. Each bermed plot was quickly filled with 600 gallons of water using a water truck resulting in a depth of approximately 10-12 inches, depending on exact plot size. A picture of Plot #1 being filled is shown Figure 3-1. The depth of the water was then monitored over 30 second time intervals until all the water in the plot area had been infiltrated. The test in each plot was repeated three times to evaluate potential reductions in infiltration rates that could occur from saturation of the profile. The third test should represent the infiltration capacity under a relatively saturated profile.

3.3.1 Results of Infiltration Tests

Detailed results from the infiltrations tests are provided in Tables A2-1 and A2-2 of Attachment 2. Figure 3-2 shows plots of the depth of water infiltrated over time shown for the third test on each plot. Results from both plots were similar while the ultimate saturated infiltration rate for Test Plot #1 was slightly higher than Plot #2. Plot #1 showed a final infiltration rate of approximately 1.24 inches per hour (iph) while, Plot #2 showed a final infiltration rate of 0.91 iph of infiltration through the surface. This rate corresponds to approximate rates of 0.77 gallons per square foot per hour (gal/ft^2/hr) and 0.56 gal/ft^2/hr. The slope of the lines in Figure 3-2 shows that infiltration did not appreciably slow down over time and became relatively steady once saturation occurred.

3.3.2 Evaluation of Infiltration Tests

There are two aspects of these data with respect to the land application of wastewater:

- These data are consistent with the well data in evaluating subsurface hydraulic and hydrogeologic properties, showing that the subsurface readily intakes and drains water that has been infiltrated through the surface. As previously noted, the K measured in the subsurface and the infiltration rate through the ground surface is not directly comparable. However, the measured rate of infiltration 1.24 and 0.91 iph (2.48 and 1.82 ft/day), respectfully, are the same order of magnitude as the average measured K (6.76 ft/day).
- The infiltration rate does not appreciably slow down over time and remains consistent. The values of 1.24 and 0.91 iph (0.77 and 0.56 gal/ft^2/hr) would represent a reasonable maximum application rate to prevent runoff of water over the surface.

3.4 Pilot-scale Application Test

A spray apparatus and evaporator was identified that could be used for both a pilot-scale field test as well as for full scale disposal. The Landshark and Landshark-45 evaporator systems are manufactured by Western Pump and Dredge in Grand Junction, Colorado. The Landshark-45 is a trailer or skid mounted unit consisting of a ring manifold of 30 spiral jet spray nozzles mounted in front of a powerful 30-inch diameter fan. The fan effectively atomizes the water spraying from the nozzles thereby creating a fine mist with a very small droplet size.

The Landshark-45 can be equipped with its own pumping system or an existing pumping system can be plumbed into the ring manifold. The flow requirement for the pumping system is 45 gallons per minute (gpm) with a pressure in the ring manifold of 80 to 100 pounds per square inch (psi). The fan unit requires 460 volt, 3 phase electrical power and includes a NEMA 4x stainless steel control panel with 2 start/stop controls.

Evaporation rates depend greatly on weather conditions such as ambient temperature, relative humidity, and wind speed. The Landshark has shown evaporation rates ranging

from 20 to 80 percent depending on weather conditions. Given the climate conditions in Nome Alaska, it can be assumed that evaporation rates for the Landshark will be at the low end of the expected range.

A known test plot of 5,000 square feet was identified near the bottom of the slope of the A3 area. The test area was chosen because it is typical in slope and surface features as the rest of the proposed disposal area and because it was a convenient area to run piping to run the test. The specific location was uphill from the thickener plant and approximately 100 feet upslope from DC3. The pump providing water via a fire hose generated approximately 200 psi of pressure with an estimated pumping capacity of 70 to 75 gpm while the output spray capacity of the Landshark is 45 gpm. A certified electrician was unavailable at the time of the test to wire the 460 volt 3-phase fan unit; therefore, the fan (blower) component of the Landshark-45 was not operational during the test. As a result, the distribution of water during the test was based purely on the power of the water pump and much more limited than would have been the case had the blower been operational. The Landshark was situated so that the output of the sprayers faced east, which was the downwind direction during the period of the test. The Land Shark was operated for two hours continuously from approximately 9:00 AM until 11:00 AM on 8/30/2009. Approximately 5,900 gallons of water was pumped through the system.

3.4.1 *Results of Pilot-scale Application Test*

The output of the Landshark consisted of a mixture of coarse water droplets and fine mist. With the fan operating, the output is solely a fine mist so this test provided a worst-case condition for an application rate per square unit area. This is because the airflow of the blower fan is in excess of 100 miles per hour (mph). The water droplets carried approximately 20 to 30 feet from the Landshark. After a period of time, some ponding was observed in small depressions on the ground surface in the area where the coarse water droplets landed. The width of the ponded area was approximately 15 feet but there was no appreciable runoff. The mist component drifted in the wind with most of it landing on the ground in the 30 to 70 foot range from the Landshark and over a broader, approximate 40 feet wide area. The finest mist component appeared to carry almost indefinitely. While the organic mat was obviously saturated surrounding the ponded area where the coarse droplets landed, the area receiving the mist component (30 to 50 feet from the sprayers) was wet but not saturated and no ponding was noted at any time. The water in the ponded area did not appreciably run off the surface, did not develop sheet flow, and infiltrated within a short time after the two-hour test.

3.4.2 Evaluation of Pilot-scale Application Test

The test occurred in wet conditions with intermittent rain and fog so it was assumed that little evaporation of the mist portion of the spray took place. Under warmer, drier conditions and with the blower fan operating normally at 100 mph, it is assumed that some evaporation of the water will occur and the application area of the spray mist will be much larger than was observed in the test. The lack of the blower unit within the Landshark clearly meant that the test was a worst-case scenario for dispersion of mist and

rate of application. However, the test was successful despite the blower not being engaged. The mist component during the test application was extremely fine and well distributed outside of the area covered by the coarse droplets. The application of 5,900 gallons of water over a relatively small area with insignificant surface runoff confirms earlier estimates from the infiltration tests (Section 3.3) indicating that the ground has a relatively high capacity to infiltrate water. Based on the behavior of the mist component, saturation immediately in front of the application unit would not have been observed if the fan unit was operational. A video of Landshark and Landshark-45 (used for this test) can be viewed at http://www.resourcewest.net/videolarge.htm. As can be seen in this video, the addition of the blower enhances the misting of the spray and will ensure a relatively low application rate over a moderately large area. An output of 45 gpm from the Landshark-45 over a 3,000 square foot area (75 feet x 40 feet) would correspond to an application rate of 0.01 iph. This rate is well under the assumed maximum rate of application of 0.91 iph which resulted from the infiltration tests (Section 3.3), and this should help avoid the development of subsurface groundwater flow.

4.0 SUMMARY AND CONCLUSIONS

Based on the test results discussed in Sections 3.1 through 3.4, the land application of wastewater to the A3 area is considered technically feasible. This evaluation was based on the following conclusions from the study.

- The dense vegetation cover at the surface will resist any erosion or entrainment of soils by "rain drop impact" and interrill erosion. The density of stems and grasses will promote interception of water (on the vegetation itself) and inhibit the development of rills and the surface transport of water downgradient. These vegetation properties essentially promote infiltration into the subsurface. The relatively deep penetrating root structure will also provide conduits for water transport to the subsurface.
- A conservative assumption of the effective porosity of the soils observed in the profiles is 40 percent. Given a 10 acre area with an average soil depth of 5 feet, this porosity corresponds to 20 acre-feet or approximately 6.5 million gallons. The high degree of gravels and cobbles particularly in the lower soil profile, should promote drainage to lower zones and into the weathered bedrock. This would increase the capacity for disposal.
- While some fine silts and clays exist in the soil profile, the overall soil texture is loamy with a mixture of sands, silts, and gravels. The silty-sands seem to dominate the hydraulic and hydrogeologic flow properties (K) below the surface with only some moderate influence by the coarser gravels and cobbles.
- The moderate K values measured for the subsoil medium shows that there is only a moderate potential for the flow of water through the subsurface downgradient. These conditions could only develop if a continuously saturated zone with sustainable head (gradient) were allowed to develop. While the moderate permeability of these soils is conducive to infiltration, they will be slightly inhibitive to a large flux of groundwater flow if saturation of the subsurface is not allowed to develop for a considerable length in the downgradient direction. These data suggest that the land application system should be rotated around the landscape within the A3 area to prevent a large continuous length downgradient to become overly saturated.
- The Results of the pilot-scale field test including the application of 5,900 gallons of water over a relatively small area showed that the ground had a relatively high capacity to infiltrate water. This confirmed the measurements taken during the infiltration tests. Based on the behavior of the mist component of the spray, saturation seen immediately in front of the application unit would not have been observed if the fan unit was operational. The addition of the blower fan would enhance the misting of the spray and will ensure a relatively low application rate over a moderately large area. An output of 45 gpm from the Landshark-45 over a 3,000 square foot area (75 feet x 40 feet) would correspond to an application rate of 0.01 iph. This rate is well under the assumed maximum rate of application of 0.91 iph which resulted from the infiltration tests.

5.0 PROPOSAL FOR LAND APPLICATION

NovaGold is proposing to land apply wastewater from the Main and South sumps and the TSF to the A3 area using one Landshark-45 evaporator-sprayer unit, with a maximum application capacity of 45 gpm, and one standard size Landshark. The standard sized Landshark has a larger application capacity up to 125 gpm. Based on the results and conclusions of the feasibility study, this application would be conducted using the following operating procedures and BMPs:

- Water from TSF will only be land applied if water quality monitoring continues to demonstrate that metals and TDS levels are consistent with sump water and cyanide levels are below 5 µg/L.
- Only the Landshark sprayer units will be used for the land application of wastewater and these units will only be operated with the blower fans running. This BMP will ensure that any evaporative component of the application is maximized and that the misting of the spray is maximized. This BMP will also help prevent the development of subsurface saturated zones and flow initiating downgradient.
- The multiple Landshark sprayer units will be located so the spray applications do not overlap on the surface of the ground. This BMP will ensure that the application rate stays well below a rate that could promote surface runoff.
- Applications would only occur during daylight hours and will be visually monitored at least once every two hours. This BMP will allow for the sprayer units to be shut down should there be any equipment breakdown, broken water pipes or power outage to the blower fans. This BMP helps ensure that uncontrolled runoff or discharge from broken equipment or a broken pipe, etc. does not flow unchecked to the ditches or area streams. A record will be kept and initialed each two-hour period by an employee with any comments noted regarding the piping, pumps, sprayers, and blower fans. This record will be made available to ADEC upon request.
- Applications would only occur if the ambient temperature is above 35° F. This BMP will ensure that applied water is not freezing on the ground or on vegetation before it is infiltrated.
- Applications will not occur if the ground surface is noticeably frozen. Because overnight temperatures could cause freezing of water or the ground surface where applications were made the previous day, the ground surface will be inspected prior to turning the sprayer units on each day. NovaGold will record the temperature at the mine site every 2 hours during operation of the sprayers.
- NovaGold will develop operating procedures to safely drain piping and the sprayer units at night if there is potential for freezing temperatures overnight.
- Applications would be halted during heavy rain if it is determined that the spray-evaporators could potentially add to ground saturation or runoff.

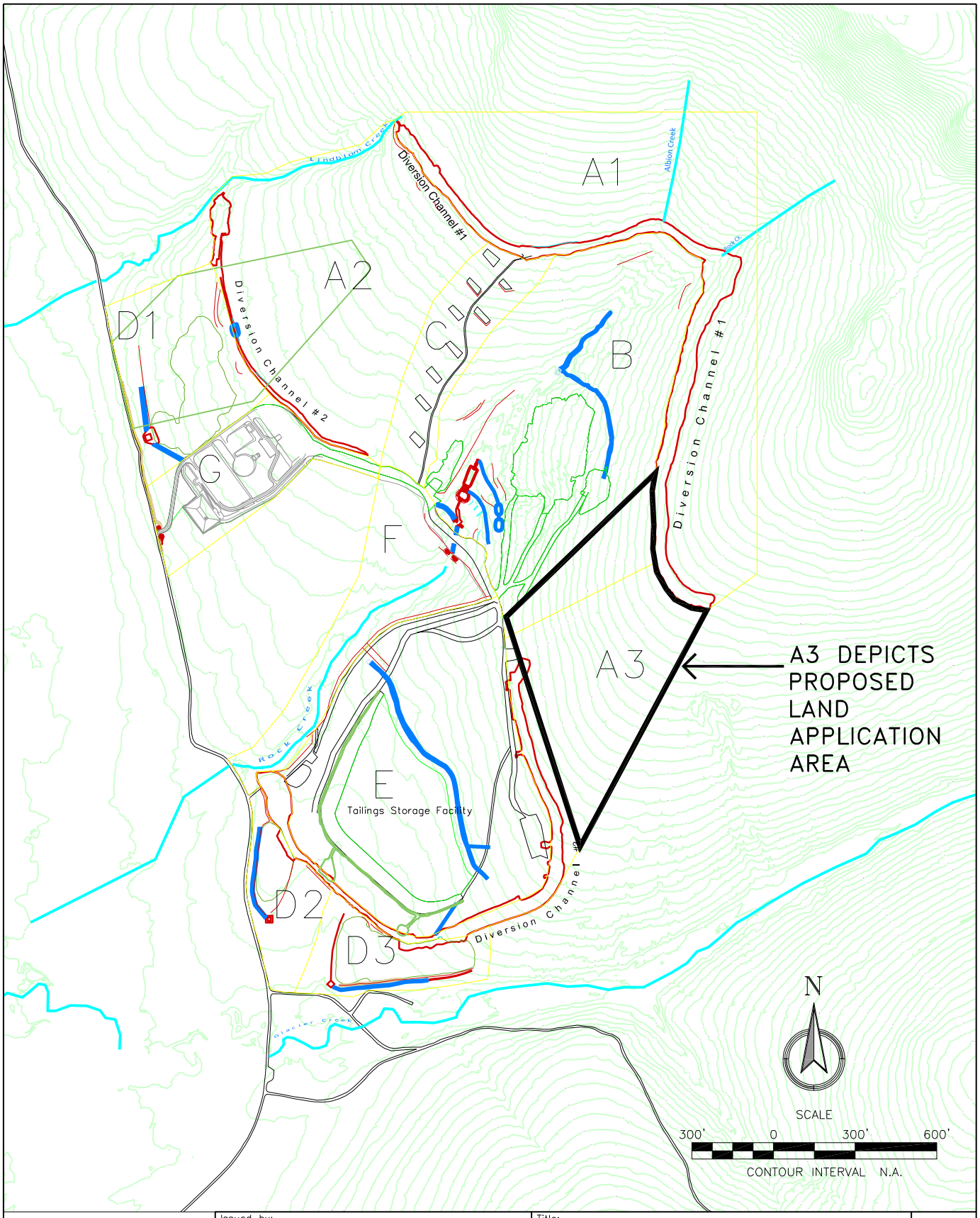
- Initial applications will be conducted at the bottom of the slope where there is better infrastructure and quicker access to the equipment and sprayers. Once additional piping and electrical access is in place, applications would be started near the upslope of the A3 hillside and generally proceed across the upper portions of the hillside. Application areas would then proceed down hill and then across the hill successively. This BMP will allow application areas to be effectively rotated, ensure that the entire disposal area is utilized, and help prevent subsurface saturated zones of significant length from developing downgradient. NovaGold will keep a record of the location of each sprayer unit, dates and hours of operation, and dates that units were rotated to different areas. These records will be made available to ADEC upon request.
- Sprayer units will be rotated according to the above rotation plan at a minimum of every three days. This BMP will allow application areas to be effectively rotated and help prevent subsurface saturated zones of significant length from developing downgradient. The application will be halted should any ponding or spongy soaked ground occur on the surface or if surface runoff is noted during the 2-hour equipment inspections. The spray unit(s) will be moved and rotated to a different area should these conditions occur.
- Field observations have shown that some historic ditches occur along the A3 hillside in addition to the DC3 diversion. These ditches and the DC3 diversion ditch will be inspected once each day of operation to look for visual signs of seepage along the ditch walls. If seepage is noted, the application will be stopped and the spray unit(s) will be moved and rotated to a different area. If seepage along a ditch wall continues for more than 3 days, the application will be stopped until the seepage stops. This BMP will indicate if the subsurface has become saturated and significant groundwater flow is developing downgradient. NovaGold will keep a record of all ditch inspections and make photographs of any noted seepage. These records will be made available to ADEC upon request.
- The three test wells (Figure 1) that were installed to conduct the hydrogeologic characterization for the feasibility study will be monitored every 2 days to determine if a water table is developing. These wells are located at the toe of the slope and will indicate if groundwater flow is developing downgradient and could potentially flow off the A3 area. If a groundwater table is encountered in these test wells, the land application will be stopped and ADEC notified. NovaGold will keep a record of all well inspections. These records will be made available to ADEC upon request.

It is anticipated that land application in the A3 area will be possible for 30 to 45 days, depending on weather conditions. Assuming an application rate of 175 gpm using the two sprayer-evaporation units and an average application of 11 hours per day, it is anticipated that up to 5 million gallons can be land applied during this period. If some evaporation can be achieved and some infiltration to bedrock occurs, it is anticipated that up to 7 million gallons could potentially be disposed during this period.

Table 5-1 summarizes record keeping that will be maintained during the land application:

Table 5-1. Summary of Land Application Monitoring Program		
Description of Monitoring and Records	**Frequency**	**Action Taken**
Equipment check for operation, including piping, pumps, sprayers, and blower fans.	Every 2-hours during operation.	Application halted until fixed.
Ambient temperature - checklist	Every 2-hours during operation	Application halted if ambient temperature < 35° F
Record of sprayer location, dates and hours of operation	Various	Sprayers must be rotated according to BMPs at a minimum of every three days.
Ponding of water, spongy soaked ground – records kept	Every 2-hours during operation	Application halted and sprayers rotated to a new area
Check for seepage along hillside ditches and in DC3 – record kept	Daily	Seepage photographed. Application halted and sprayers rotated to a new area. Application stopped and ADEC notified if seepage continues for more than 3 days.
Test wells checked for water table	Every 2-days	Application stopped and ADEC notified.
Water quality will be monitored in the monitoring wells downgradient of the TSF	Per the Solid Waste Permit	Corrective measures will be implemented for the TSF and/or the land application system if data indicates a variation from background.

FIGURES



Issued by:

TETRA TECH
350 Indiana Street, Suite 500
Golden, Colorado 80401
(303) 217-5700 (303) 217-5705 fax

Title:

ROCK CREEK MINE
BASE MAP

A
REVISION

Project:	Project no.:	DRAWING/FIGURE
NOVA GOLD	310979	FIGURE 1
Location: NOME, ALASKA	Date: 08/09	

Dumont, Dennis – T:\CLIENTS\NOVA GOLD\ROCK CREEK MINE\PROJECT\CAD\C3D – PROJ NAME\DRAFT\DWGS\FIGURE 1_ROCK CREEK MINE BASE MAP.DWG – Wednesday, August 05, 2009 10:19:40 AM

Figure 2-1. Soil Profile of Test Pit #1.

Figure 2-2. Soil Profile of Test Pit #2.

Figure 2-3. Soil Profile of Test Pit #3.

Figure 3-1. Filling of Infiltration Test Pit.

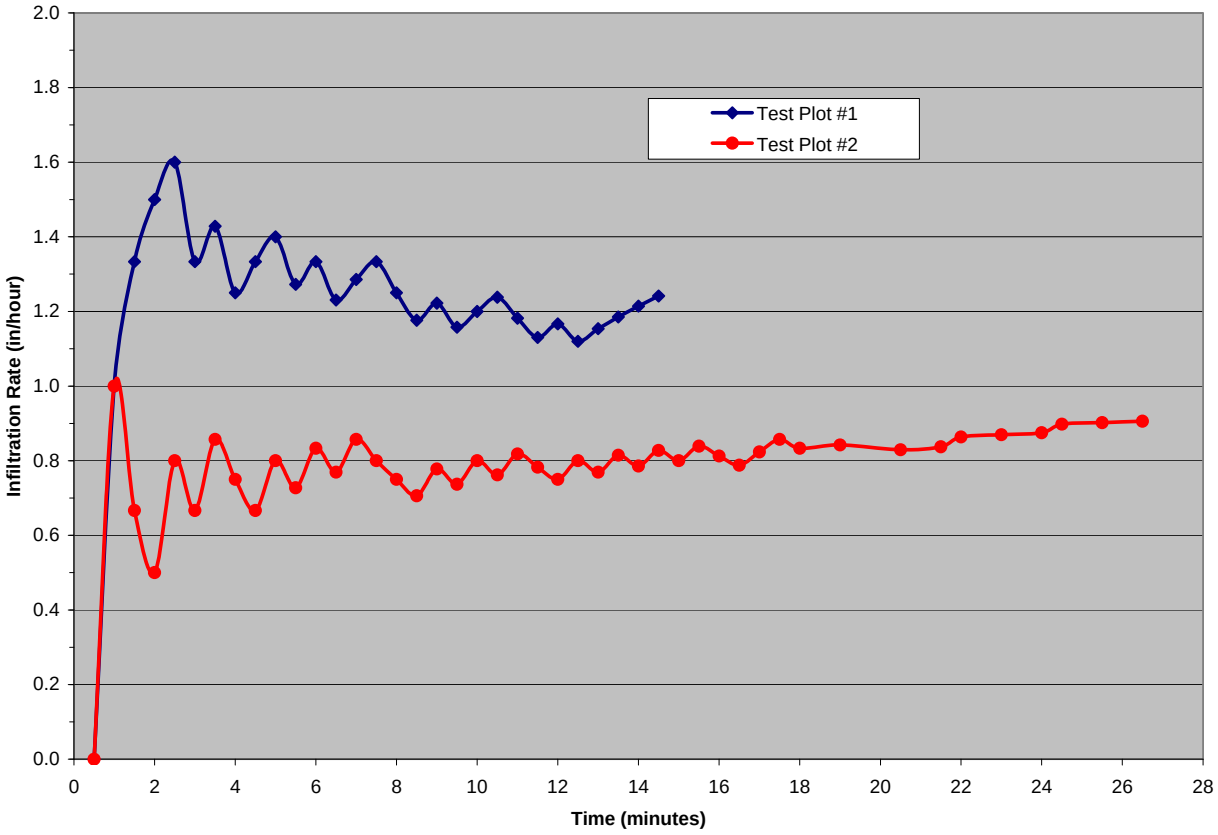


Figure 3-2. Results of falling head infiltration pit tests. Results are for the third replicate in each test pit.

ATTACHMENT 1

DETAILED RESULTS FOR TEST WELLS
HYDRAULIC CONDUCTIVITY

HydroGeo, Inc.
Surface & Groundwater Hydrology

Slug Test - Water Level Data

Project: Rock Creek Land Application Project

Number:

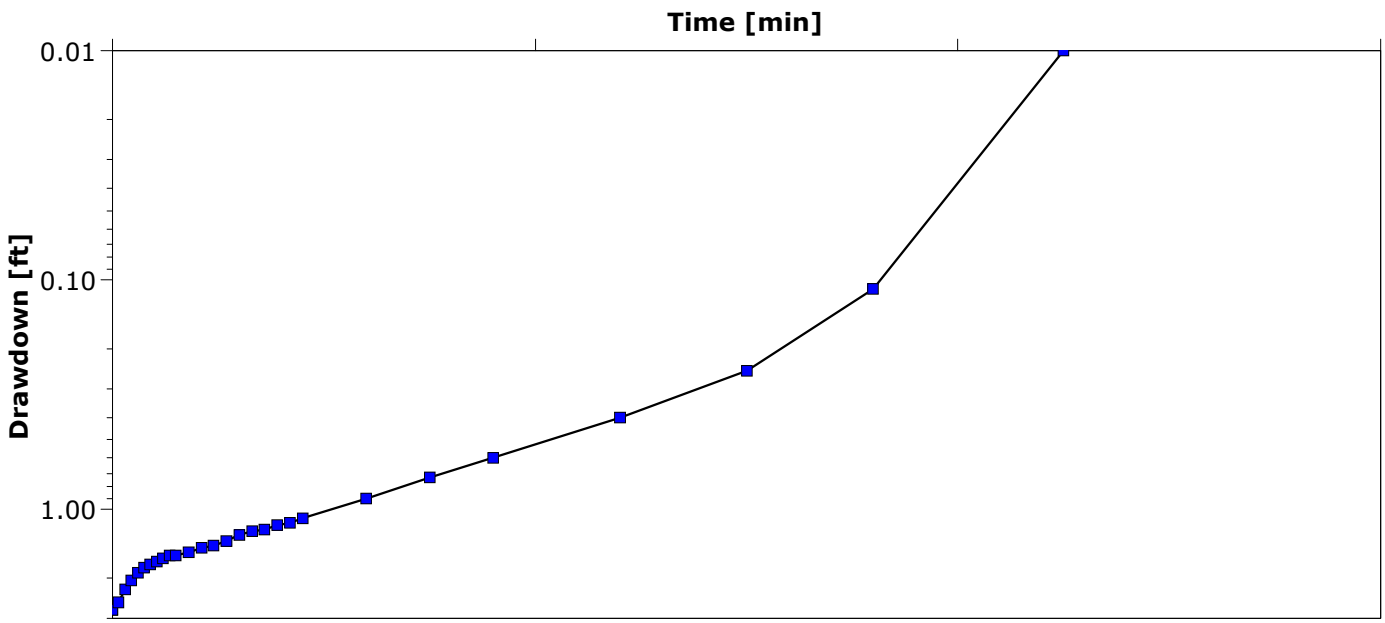
Client: Nova Gold

Location:	Slug Test: Slug Test TW-1	Test Well: TW-1
Test Conducted by: JF	Test Date: 8/21/2009	
Water level at t=0 [ft]: 7.10	Static Water Level [ft]: 9.85	Water level change at t=0 [ft]: 2.75

	Time [min]	Water Level [ft]	WL Change [ft]
1	0	7.10	2.75
2	0.5	7.30	2.55
3	1	7.60	2.25
4	1.5	7.80	2.05
5	2	7.95	1.90
6	2.5	8.05	1.80
7	3	8.10	1.75
8	3.5	8.15	1.70
9	4	8.20	1.65
10	4.5	8.25	1.60
11	5	8.25	1.60
12	6	8.30	1.55
13	7	8.37	1.48
14	8	8.40	1.45
15	9	8.47	1.38
16	10	8.55	1.30
17	11	8.60	1.25
18	12	8.62	1.23
19	13	8.67	1.18
20	14	8.70	1.15
21	15	8.75	1.10
22	20	8.95	0.90
23	25	9.12	0.73
24	30	9.25	0.60
25	40	9.45	0.40
26	50	9.60	0.25
27	60	9.74	0.11
28	75	9.84	0.01

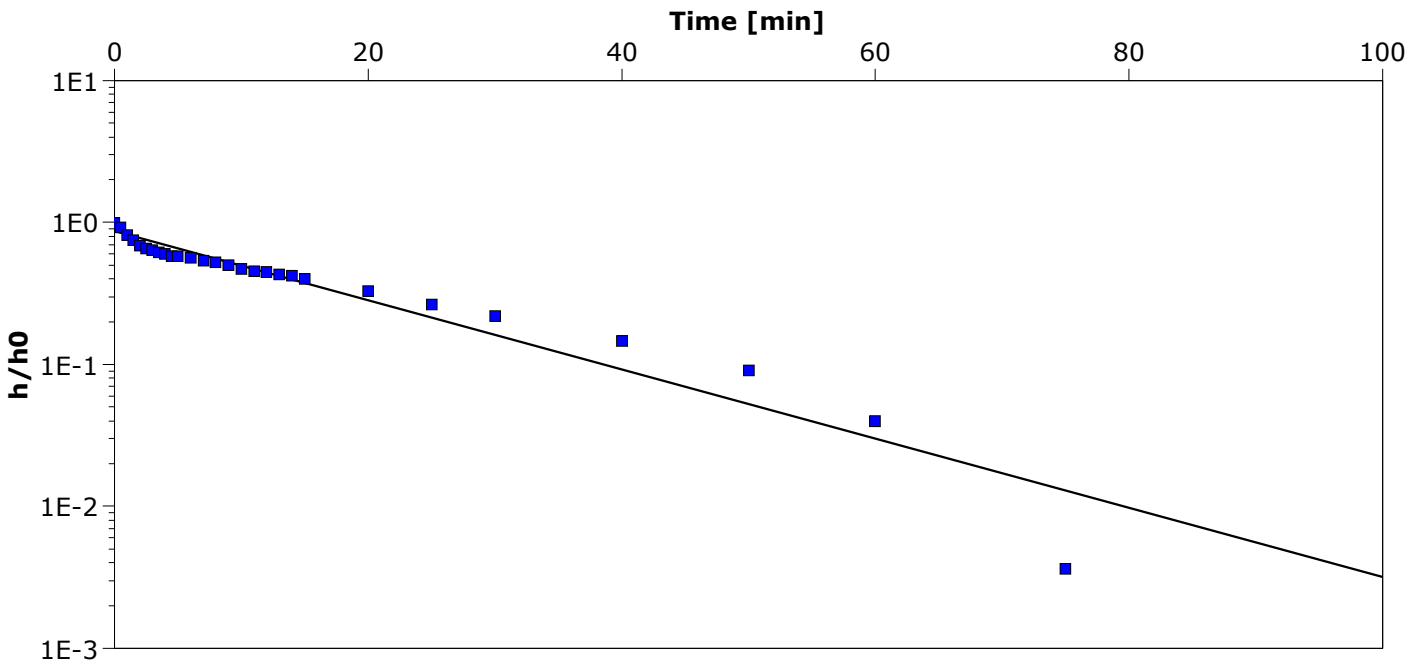
HydroGeo, Inc. Surface & Groundwater Hydrology	**Slug Test Analysis Report**
	Project: Rock Creek Land Application Project
	Number:
	Client: Nova Gold

Location:	Slug Test: Slug Test TW-1	Test Well: TW-1
Test Conducted by: JF		Test Date: 8/21/2009
Analysis Performed by:	Time vs. Change in WL	Analysis Date: 8/25/2009
Aquifer Thickness: 0.00 ft		



HydroGeo, Inc. Surface & Groundwater Hydrology	**Slug Test Analysis Report**
	Project: Rock Creek Land Application Project
	Number:
	Client: Nova Gold

Location:	Slug Test: Slug Test TW-1	Test Well: TW-1
Test Conducted by: JF		Test Date: 8/21/2009
Analysis Performed by:	Hvorslev	Analysis Date: 8/25/2009
Aquifer Thickness: 0.00 ft		

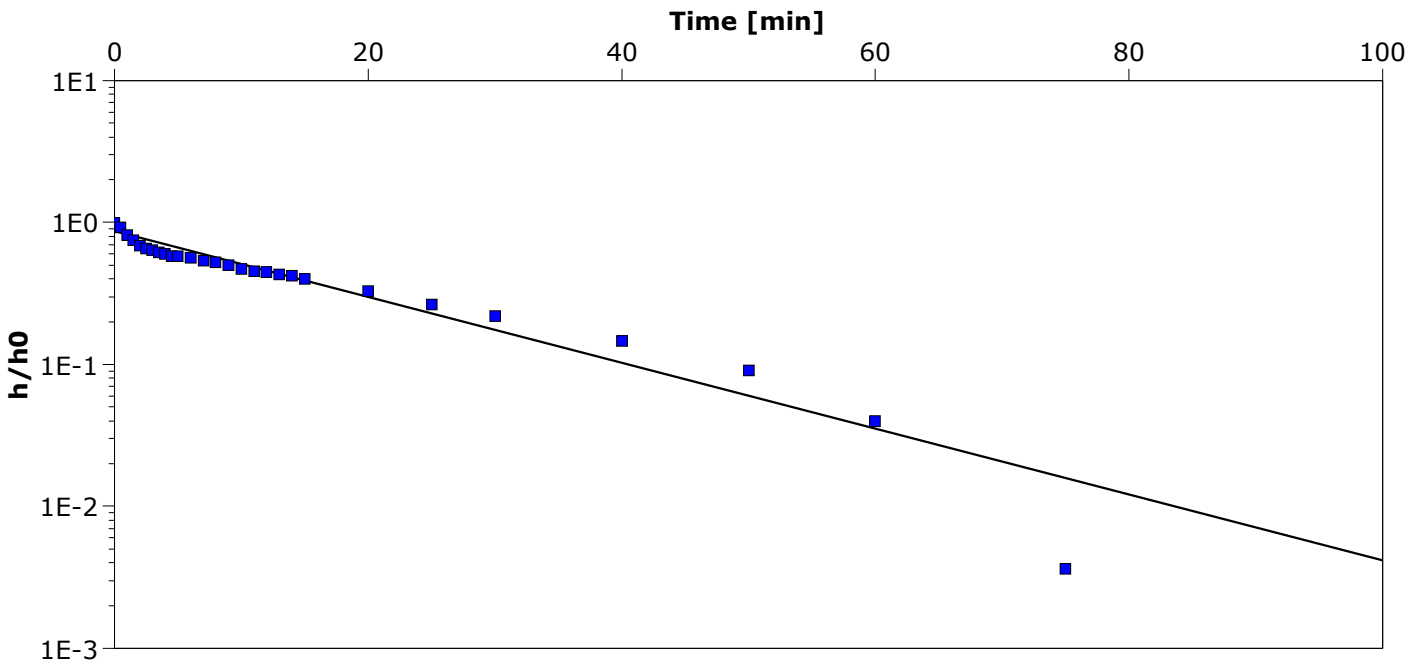


Calculation after Hvorslev

Observation Well	Hydraulic Conductivity [cm/s]	
TW-1	8.15×10^{-5}	

HydroGeo, Inc. Surface & Groundwater Hydrology	**Slug Test Analysis Report**
	Project: Rock Creek Land Application Project
	Number:
	Client: Nova Gold

Location:	Slug Test: Slug Test TW-1	Test Well: TW-1
Test Conducted by: JF		Test Date: 8/21/2009
Analysis Performed by:	Bouwer & Rice	Analysis Date: 8/25/2009
Aquifer Thickness: 0.00 ft		



Calculation after Bouwer & Rice

Observation Well	Hydraulic Conductivity [cm/s]	
TW-1	5.96×10^{-5}	

HydroGeo, Inc.
Surface & Groundwater Hydrology

Slug Test - Analyses Report

Project: Rock Creek Land Application Project

Number:

Client: Nova Gold

Location:	Slug Test: Slug Test TW-1	Test Well: TW-1
Test Conducted by: JF		Test Date: 8/21/2009
Aquifer Thickness: 0.00 ft		

Analysis Name	Analysis Performed by	Analysis Date	T [cm²/s]	K [cm/s]	S
Hvorslev		8/25/2009		8.15×10^{-5}	
Bouwer & Rice		8/25/2009		5.96×10^{-5}	
		Average		7.06×10^{-5}	

HydroGeo, Inc.
Surface & Groundwater Hydrology

Slug Test - Water Level Data

Project: Rock Creek Land Application Project

Number:

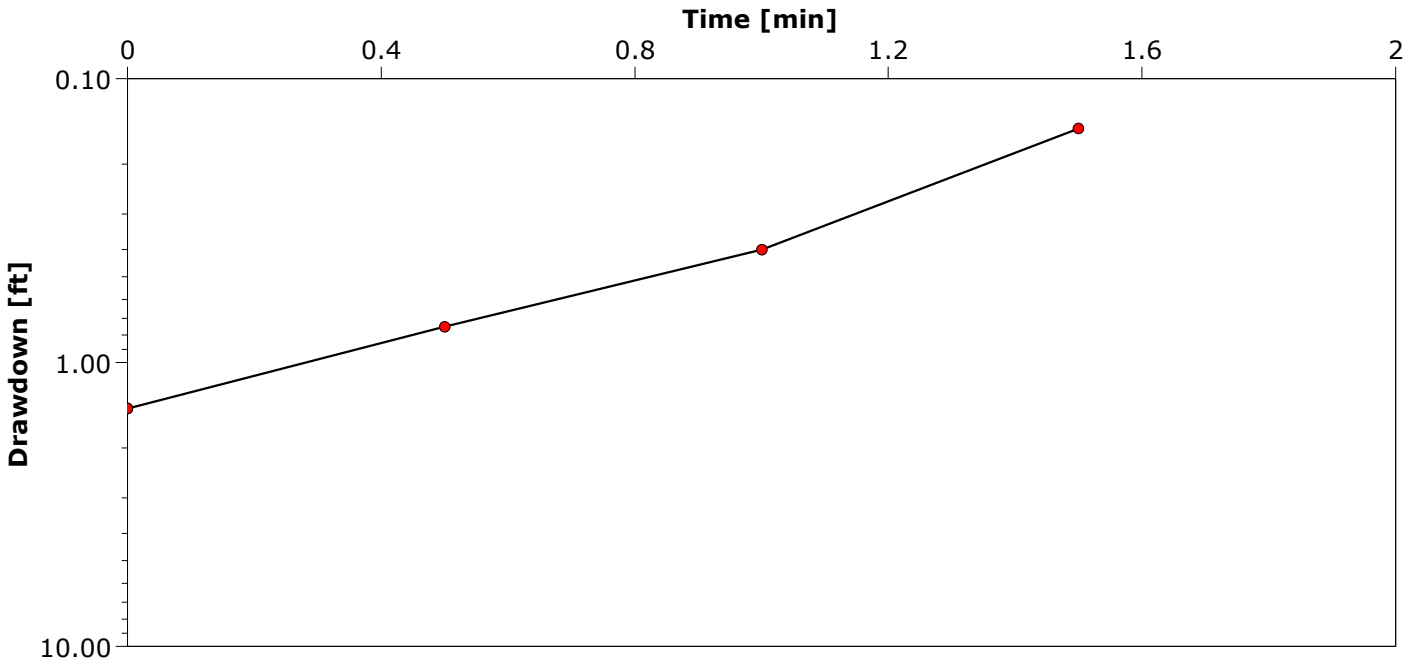
Client: Nova Gold

Location:	Slug Test: Slug Test TW-2	Test Well: TW-2
Test Conducted by: JF	Test Date: 8/21/2009	
Water level at t=0 [ft]: 4.50	Static Water Level [ft]: 5.95	Water level change at t=0 [ft]: 1.45

	Time [min]	Water Level [ft]	WL Change [ft]
1	0	4.50	-1.45
2	0.5	5.20	-0.75
3	1	5.55	-0.40
4	1.5	5.80	-0.15
5	2	5.95	0.00

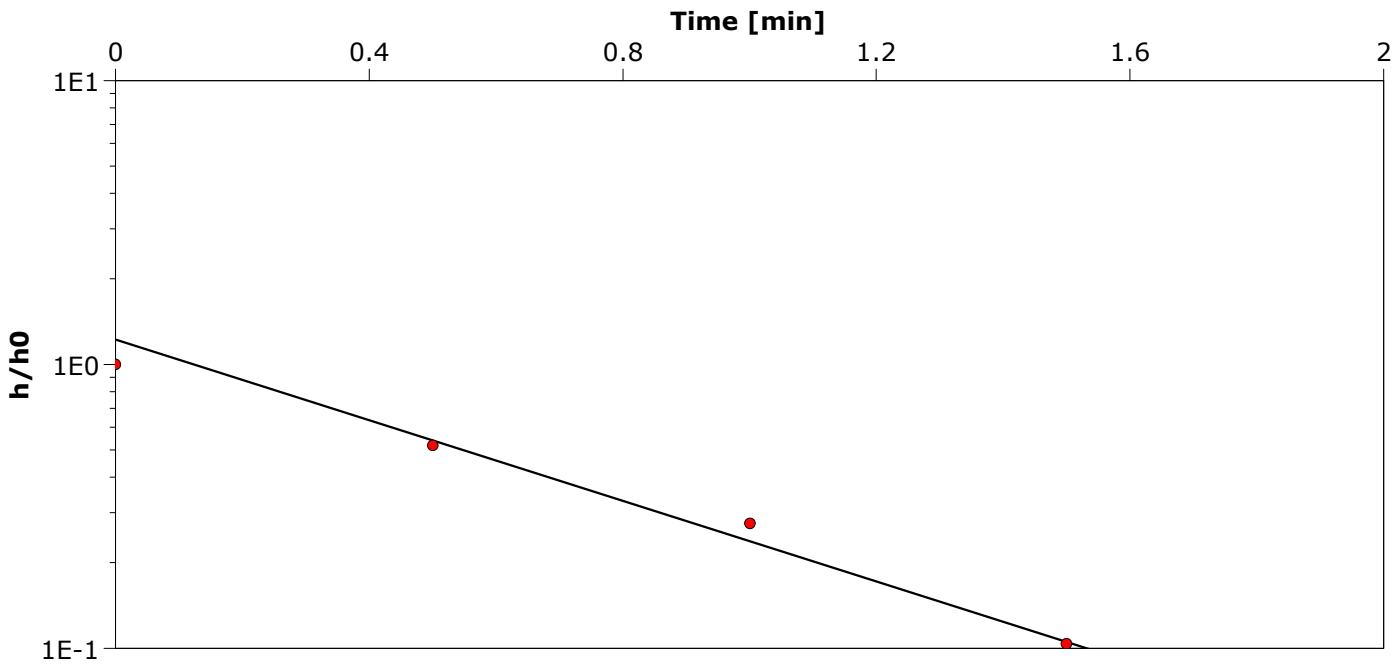
HydroGeo, Inc. Surface & Groundwater Hydrology	**Slug Test Analysis Report**
	Project: Rock Creek Land Application Project
	Number:
	Client: Nova Gold

Location:	Slug Test: Slug Test TW-2	Test Well: TW-2
Test Conducted by: JF		Test Date: 8/21/2009
Analysis Performed by:	Time vs Change in WL	Analysis Date: 8/25/2009
Aquifer Thickness: 0.00 ft		



HydroGeo, Inc. Surface & Groundwater Hydrology	**Slug Test Analysis Report**
	Project: Rock Creek Land Application Project
	Number:
	Client: Nova Gold

Location:	Slug Test: Slug Test TW-2	Test Well: TW-2
Test Conducted by: JF		Test Date: 8/21/2009
Analysis Performed by:	Hvorslev	Analysis Date: 8/25/2009
Aquifer Thickness: 0.00 ft		

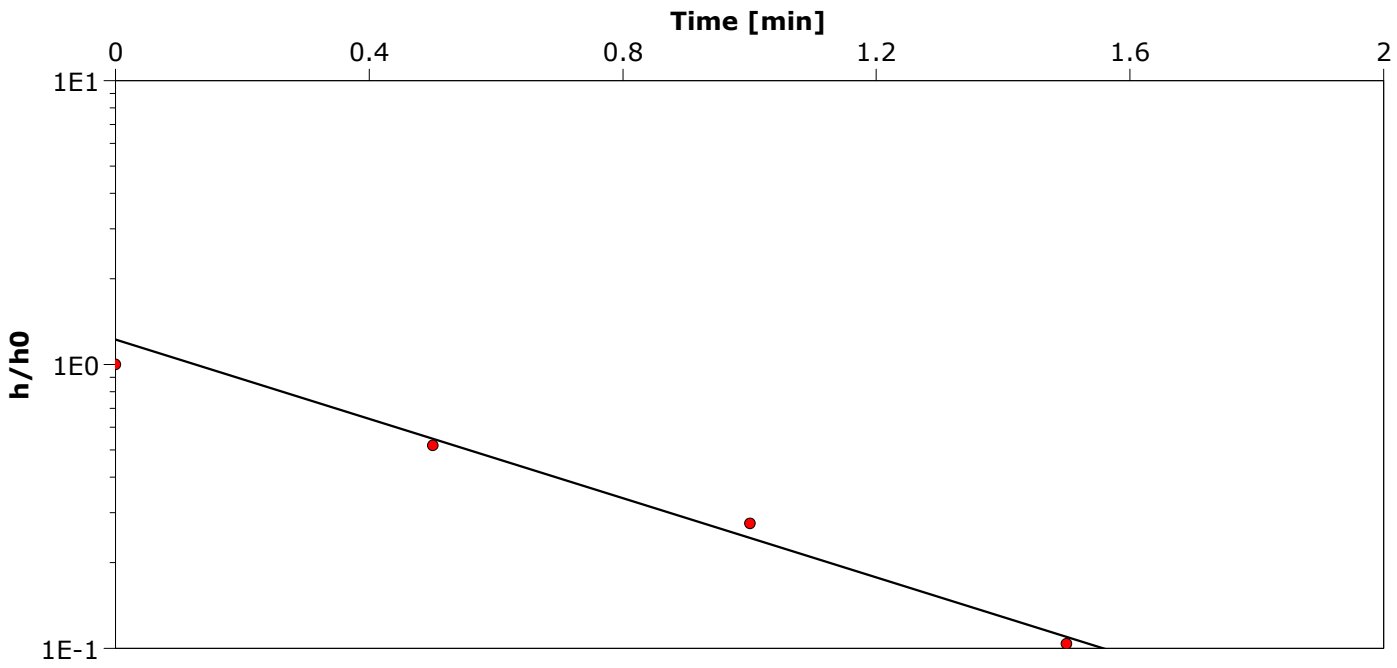


Calculation after Hvorslev

Observation Well	Hydraulic Conductivity [cm/s]	
TW-2	3.47×10^{-3}	

HydroGeo, Inc. Surface & Groundwater Hydrology	**Slug Test Analysis Report**
	Project: Rock Creek Land Application Project
	Number:
	Client: Nova Gold

Location:	Slug Test: Slug Test TW-2	Test Well: TW-2
Test Conducted by: JF		Test Date: 8/21/2009
Analysis Performed by:	Bouwer & Rice	Analysis Date: 8/25/2009
Aquifer Thickness: 0.00 ft		



Calculation after Bouwer & Rice

Observation Well	Hydraulic Conductivity [cm/s]	
TW-2	2.60×10^{-3}	

HydroGeo, Inc.
Surface & Groundwater Hydrology

Slug Test - Analyses Report

Project: Rock Creek Land Application Project

Number:

Client: Nova Gold

Location:	Slug Test: Slug Test TW-2	Test Well: TW-2
Test Conducted by: JF		Test Date: 8/21/2009
Aquifer Thickness: 0.00 ft		

Analysis Name	Analysis Performed by	Analysis Date	T [cm²/s]	K [cm/s]	S
Hvorslev		8/25/2009		3.47×10^{-3}	
Bouwer & Rice		8/25/2009		2.60×10^{-3}	
		Average		3.03×10^{-3}	

HydroGeo, Inc.
Surface & Groundwater Hydrology

Slug Test - Water Level Data

Project: Rock Creek Land Application Project

Number:

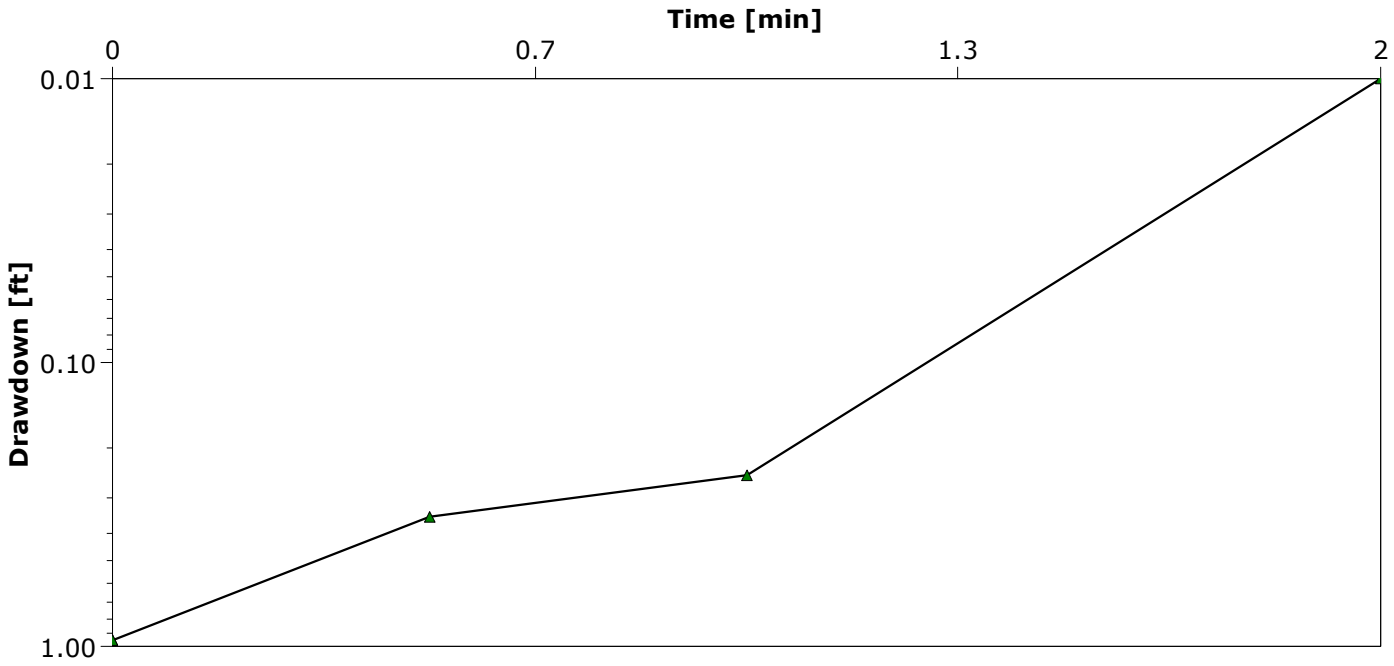
Client: Nova Gold

Location:	Slug Test: Slug Test TW-3	Test Well: Well 3
Test Conducted by: JF	Test Date: 8/21/2009	
Water level at t=0 [ft]: 4.20	Static Water Level [ft]: 5.15	Water level change at t=0 [ft]: 0.95

	Time [min]	Water Level [ft]	WL Change [ft]
1	0	4.20	-0.95
2	0.5	4.80	-0.35
3	1	4.90	-0.25
4	2	5.14	-0.01

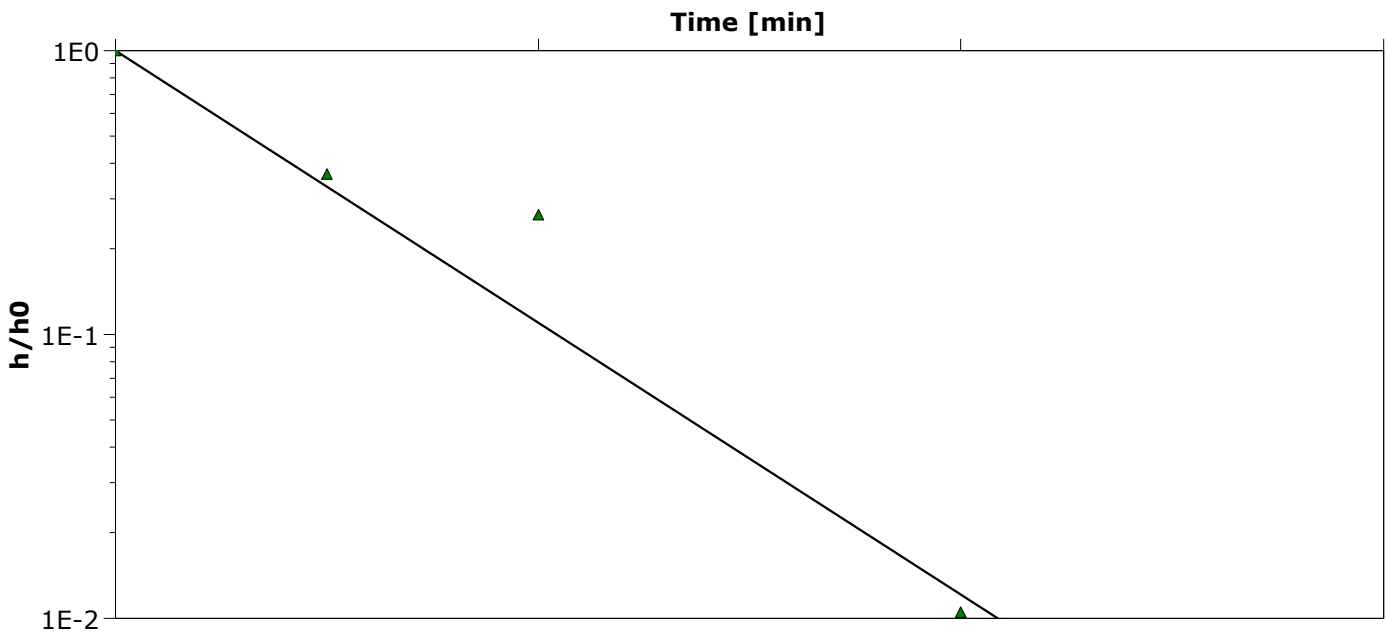
HydroGeo, Inc. Surface & Groundwater Hydrology	**Slug Test Analysis Report**
	Project: Rock Creek Land Application Project
	Number:
	Client: Nova Gold

Location:	Slug Test: Slug Test TW-3	Test Well: Well 3
Test Conducted by: JF		Test Date: 8/21/2009
Analysis Performed by:	Time vs Change in WL	Analysis Date: 8/25/2009
Aquifer Thickness: 0.20 ft		



HydroGeo, Inc. Surface & Groundwater Hydrology	**Slug Test Analysis Report**
	Project: Rock Creek Land Application Project
	Number:
	Client: Nova Gold

Location:	Slug Test: Slug Test TW-3	Test Well: Well 3
Test Conducted by: JF		Test Date: 8/21/2009
Analysis Performed by:	Hvorslev	Analysis Date: 8/25/2009
Aquifer Thickness: 0.20 ft		

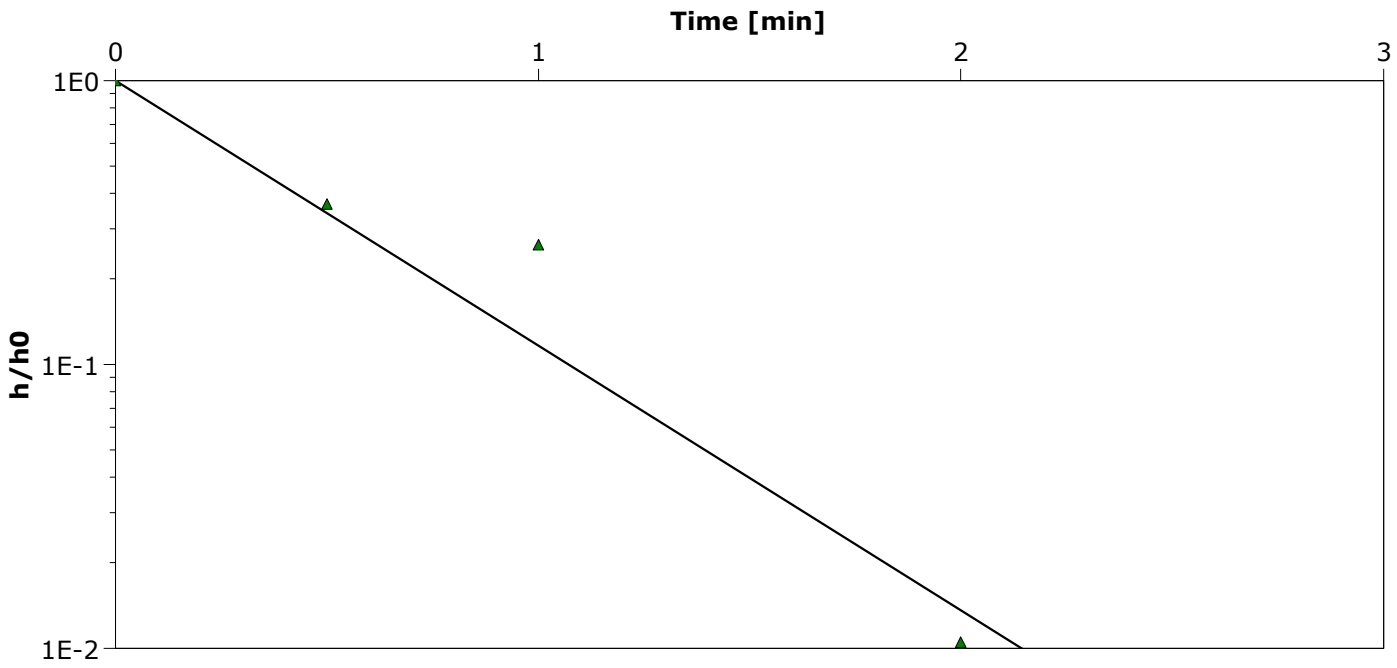


Calculation after Hvorslev

Observation Well	Hydraulic Conductivity [cm/s]	
Well 3	4.68×10^{-3}	

HydroGeo, Inc. Surface & Groundwater Hydrology	**Slug Test Analysis Report**
	Project: Rock Creek Land Application Project
	Number:
	Client: Nova Gold

Location:	Slug Test: Slug Test TW-3	Test Well: Well 3
Test Conducted by: JF		Test Date: 8/21/2009
Analysis Performed by:	Bouwer & Rice	Analysis Date: 8/25/2009
Aquifer Thickness: 0.20 ft		



Calculation after Bouwer & Rice

Observation Well	Hydraulic Conductivity [cm/s]	
Well 3	3.47×10^{-3}	

HydroGeo, Inc.
Surface & Groundwater Hydrology

Slug Test - Analyses Report

Project: Rock Creek Land Application Project

Number:

Client: Nova Gold

Location:	Slug Test: Slug Test TW-3	Test Well: Well 3
Test Conducted by: JF		Test Date: 8/21/2009
Aquifer Thickness: 0.20 ft		

Analysis Name	Analysis Performed by	Analysis Date	T [cm²/s]	K [cm/s]	S
Hvorslev		8/25/2009		4.68×10^{-3}	
Bouwer & Rice		8/25/2009		3.47×10^{-3}	
		Average		4.07×10^{-3}	

ATTACHMENT 2

DETAILED RESULTS FOR INFILTRATION TEST PITS

Table A2-1. Infiltration Trials for Test Plot #1								
Test 1			Test 2			Test 3		
Time	Depth	Infiltration Rate	Time	Depth	Infiltration Rate	Time	Depth	Infiltration Rate
seconds	inches	in/hr	seconds	inches	in/hr	seconds	inches	in/hr
0	9.0	--	0	9.5	--	0	9.5	--
30	8.5	2.00	30	9.0	2.00	30	9.5	0.00
60	8.0	2.00	60	8.5	2.00	60	9.0	1.00
90	8.0	1.33	90	8.0	2.00	90	8.5	1.33
120	7.5	1.50	120	8.0	1.50	120	8.0	1.50
150	7.0	1.60	150	7.5	1.60	150	7.5	1.60
180	6.5	1.67	180	7.0	1.67	180	7.5	1.33
210	6.0	1.71	210	6.5	1.71	210	7.0	1.43
240	5.5	1.75	240	6.5	1.50	240	7.0	1.25
270	5.5	1.56	270	6.0	1.56	270	6.5	1.33
300	5.0	1.60	300	6.0	1.40	300	6.0	1.40
330	5.0	1.45	330	5.5	1.45	330	6.0	1.27
360	4.5	1.50	360	5.0	1.50	360	5.5	1.33
390	4.5	1.38	390	5.0	1.38	390	5.5	1.23
420	4.0	1.43	420	4.5	1.43	420	5.0	1.29
450	4.0	1.33	450	4.5	1.33	450	4.5	1.33
480	3.5	1.38	480	4.0	1.38	480	4.5	1.25
510	3.0	1.41	510	4.0	1.29	510	4.5	1.18
540	3.0	1.33	540	4.0	1.22	540	4.0	1.22
570	3.0	1.26	570	3.5	1.26	570	4.0	1.16
600	2.5	1.30	600	3.5	1.20	600	3.5	1.20
630	2.0	1.33	630	3.0	1.24	630	3.0	1.24
660	2.0	1.27	660	3.0	1.18	660	3.0	1.18
690	1.5	1.30	690	2.5	1.22	690	3.0	1.13
720	1.0	1.33	720	2.0	1.25	720	2.5	1.17
750	0.5	1.36	750	2.0	1.20	750	2.5	1.12
--	--	--	780	1.5	1.23	780	2.0	1.15
--	--	--	810	1.0	1.26	810	1.5	1.19
--	--	--	840	1.0	1.21	840	1.0	1.21
--	--	--	870	0.5	1.24	870	0.5	1.24

Table A2-2. Infiltration Trials for Test Plot #2								
Test 1			Test 2			Test 3		
Time	Depth	Infiltration Rate	Time	Depth	Infiltration Rate	Time	Depth	Infiltration Rate
seconds	inches	in/hr	seconds	inches	in/hr	seconds	inches	in/hr
0	12.0	--	0	13.0	--	0	12.5	--
30	11.5	2.00	30	13.0	0.00	30	12.5	0.00
60	11.0	2.00	60	12.5	1.00	60	12.0	1.00
90	11.0	1.33	90	12.5	0.67	90	12.0	0.67
120	10.5	1.50	120	12.0	1.00	120	12.0	0.50
150	10.0	1.60	150	12.0	0.80	150	11.5	0.80
180	10.0	1.33	180	12.0	0.67	180	11.5	0.67
210	9.5	1.43	210	12.0	0.57	210	11.0	0.86
240	9.5	1.25	240	11.5	0.75	240	11.0	0.75
270	9.0	1.33	270	11.5	0.67	270	11.0	0.67
300	9.0	1.20	300	11.0	0.80	300	10.5	0.80
330	8.5	1.27	330	11.0	0.73	330	10.5	0.73
360	8.5	1.17	360	10.5	0.83	360	10.0	0.83
390	8.0	1.23	390	10.0	0.92	390	10.0	0.77
420	8.0	1.14	420	10.0	0.86	420	9.5	0.86
450	7.5	1.20	450	10.0	0.80	450	9.5	0.80
480	7.0	1.25	480	9.5	0.88	480	9.5	0.75
510	7.0	1.18	510	9.5	0.82	510	9.5	0.71
540	7.0	1.11	540	9.0	0.89	540	9.0	0.78
570	6.5	1.16	570	9.0	0.84	570	9.0	0.74
600	6.0	1.20	600	8.5	0.90	600	8.5	0.80
630	6.0	1.14	630	8.5	0.86	630	8.5	0.76
660	6.0	1.09	660	8.0	0.91	660	8.0	0.82
690	5.5	1.13	690	8.0	0.87	690	8.0	0.78
720	5.5	1.08	720	8.0	0.83	720	8.0	0.75
750	5.0	1.12	750	7.5	0.88	750	7.5	0.80
780	5.0	1.08	780	7.5	0.85	780	7.5	0.77
810	4.5	1.11	810	7.0	0.89	810	7.0	0.81
840	4.5	1.07	840	7.0	0.86	840	7.0	0.79
870	4.0	1.10	870	7.0	0.83	870	6.5	0.83
900	3.5	1.13	900	6.5	0.87	900	6.5	0.80
930	3.5	1.10	930	6.5	0.84	930	6.0	0.84
960	3.0	1.13	960	6.0	0.88	960	6.0	0.81
990	3.0	1.09	990	6.0	0.85	990	6.0	0.79
1020	2.5	1.12	1020	5.5	0.88	1020	5.5	0.82
1050	2.0	1.14	1050	5.0	0.91	1050	5.0	0.86
1080	2.0	1.11	1080	5.0	0.89	1080	5.0	0.83
1110	1.5	1.14	1140	4.5	0.89	1140	4.5	0.84
1140	1.0	1.16	1230	4.0	0.88	1230	4.0	0.83
1170	1.0	1.13	1290	3.5	0.88	1290	3.5	0.84
1200	0.5	1.15	1320	3.0	0.91	1320	3.0	0.86
--	--	--	1380	2.5	0.91	1380	2.5	0.87
--	--	--	1440	2.0	0.92	1440	2.0	0.88
--	--	--	1500	1.5	0.92	1470	1.5	0.90
--	--	--	1530	1.0	0.94	1530	1.0	0.90
--	--	--	1560	0.5	0.96	1590	0.5	0.91