System through-flow rates -- Because of the uncertainties in physical characteristics of the flow system, a range of reasonable flow rates was estimated for the system. The total amount of groundwater flowing through the area beneath the pits was estimated based on Darcy's Law, as follows:

$Q = K \times I \times A$

Where:

Q = total flow rate (ft^3/day)

K = hydraulic conductivity (ranging from 0.028 to 0.28 ft/day)

I = hydraulic gradient (ranging from 0.05 to 0.20 ft/ft)

A = through-flow area (assuming 3,500 ft by 500 ft for both pits)

Based on the range of values provided above, groundwater flow beneath the site could range from 2,500 ft^3/day (approximately 15 gpm) to 100,000 ft^3/day (approximately 500 gpm). The estimated range of 15 to 500 gpm encompasses the flow rates observed from discrete fracture zones during exploration drilling (0 to 120 gpm) (WMCI, 2000).

Summary of groundwater flow conditions -- The conceptual model of groundwater flow at the True North site can be summarized as follows (WMCI, 2000):

Highly localized and areally limited shallow groundwater exists above the permafrost, resulting in minor near surface flows and seeps.

The main groundwater flow system occurs where permafrost is absent and below the permafrost.

Recharge to the groundwater flow system occurs primarily along the ridge top and south facing slopes where permafrost is absent.

Groundwater flows off of the divide between the Dome Creek and Little Eldorado Creek drainages, toward the north, northeast, and northwest.

Hydraulic gradients in the site area range from 0.05 ft/ft in creek bed areas to 0.20 near the ridge top.

The hydraulic conductivity of the system ranges from 0.16 ft/day to 0.25 ft/day, with a geometric mean of 0.20 ft/day.

Groundwater through-flow rates may range from 15 to 500 gpm, representative of a relatively low flow system.

Groundwater from the site area likely discharges within Murry Creek, Spruce Creek, and Louis Creek.

3.7 WATER QUALITY

The descriptions in this section of surface water and groundwater quality, and acid generating potential, have been taken from WMCI (2000).

3.7.1 SURFACE WATER QUALITY

Baseline surface water sample collection in the True North project area has been carried out since 1994 from 18 surface locations in six different drainages. These include tributaries that drain the immediate project site, streams outside of the immediate project area, and major regional streams that will receive water draining from the proposed project site**.** Table 3.7-1 lists the specific drainages, and the main tributaries within each drainage, that historically have been sampled. The table also includes locations being carried forward for long-term sampling. All sample locations are shown in Figure 3.7-1 (WMCI, 2000).

The headwaters for portions of the North Fork of Little Eldorado Creek, the South Fork of Little Eldorado Creek, and Dome Creek all begin in the highlands that includes the proposed open pit and other planned mine facilities. Surface water samples have been (and currently are being) collected from Upper and Lower Louis Creek, Whiskey Gulch, the North and South Forks of Spruce Creek, and Murray Creek to document the pre-mine surface water chemistry in the immediate project site. Surface water samples also have been collected at sites downstream of the immediate project area, including Little Eldorado Creek,

North Fork of Little Eldorado Creek, lower Spruce Creek, South Fork of Little Eldorado Creek, Dome Creek, and Lower Dome Creek (WMCI, 2000).

Water samples collected from Marshall Gulch, Marshall Creek, and Moose Creek are within the North Fork of Little Eldorado Creek and Dome Creek drainages, respectively, but drain from highlands outside of the immediate project area. These locations provide a larger database of baseline water chemistry for areas outside of the project area. Samples collected from sites along Ruby Creek, and the North Fork of Steamboat Creek, Steamboat Creek, and Granite Creek of the Pedro Creek drainage, provide baseline water chemistry from drainage basins well outside of the project site and therefore document the range of baseline surface water chemistry (WMCI, 2000).

The North Fork of Little Eldorado Creek, South Fork of Little Eldorado Creek, and Dome Creek all discharge into the Chatanika River north and west of the project site. Surface water samples have been and are currently being collected from sites along the Chatanika River both upstream and downstream of the confluence of these streams to document the pre-mining regional surface water chemistry (WMCI, 2000).

A total of 82 surface water samples has been collected from sites in and around the True North project area. Annual water samples were collected by Newmont Mining from 1994 to 1998, with supplemental sampling at selected sites in November 1996, January 1997, and May 1997. The annual sampling program was continued in 1999 by FGMI. Table 3.7-2 summarizes the 82 sampling events and tabulates the total number of water chemical analyses available from each sampling site (WMCI, 2000).

The results of the surface water sampling program indicate there are two major water types in the True North project area, a low TDS, calcium carbonate type water and a slightly higher TDS, calcium sulfate water. The calcium sulfate type water was found in samples collected from the North Fork of Spruce Creek, the South Fork of Spruce Creek, and Whiskey Gulch. The source of the calcium and sulfate was probably the hydrothermally altered bedrock outcrops and soils

of the immediate project area. The calcium sulfate type water also was found down gradient from the project area, in Lower Spruce Creek, and the South Fork of Little Eldorado Creek. This was most likely due to the lack of dilution from other influent streams in the lower reaches of Spruce Creek (WMCI, 2000).

The pH of all water samples was near neutral and the average pH for the calcium sulfate water samples ranges from 6.8 to 7.9. The neutral pH and the lack of elevated iron concentration in the water samples suggests that the source of sulfate in the calcium sulfate type waters may be from dissolution of primary hydrothermal or secondary sulfate minerals in the soils, rather than acid generation by sulfide mineral oxidation (WMCI, 2000).

Table 3.7-1
Summary of surface water sampling sites by drainage

Sampling Scale	River/Stream	Sample Site
Regional main river baseline water chemistry	Chatanika River	Chatanika River above Little Eldorado Creek (1) (2)
		Chatanika River below Dome Creek (1) (2)
		Chatanika River above Dome Creek (1)
Tributary baseline water chemistry	North Fork Little Eldorado Ck drainage	Upper Louis Creek (1)
		Lower Louis Creek (1)
		Whiskey Gulch (1)
		Marshall Gulch (1)
		Marshall Creek (2)
		Little Eldorado Creek (2)
		North Fork Little Eldorado Ck (1)
	South Fork Little Eldorado Ck drainage	South Fork Spruce Creek (1)
		North Fork Spruce Creek (1)
		Lower Spruce Creek (1)
		Spruce Creek (2)
		South Fork Little Eldorado Ck (1)
	Dome Ck drainage	Murray Creek (1)
		Moose Creek (1)
		Lower Dome Creek (1)
		Dome Creek (2)
	Ruby Ck drainage	Ruby Creek (1)
	Pedro Ck drainage	North Fork Steamboat Creek (1)
		Steamboat Creek (2)
		Granite Creek (1)

(1) Sites sampled by Newmont

(2) Sites sampled by FGMI

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Figure 3.7-1 Surface water sampling locations

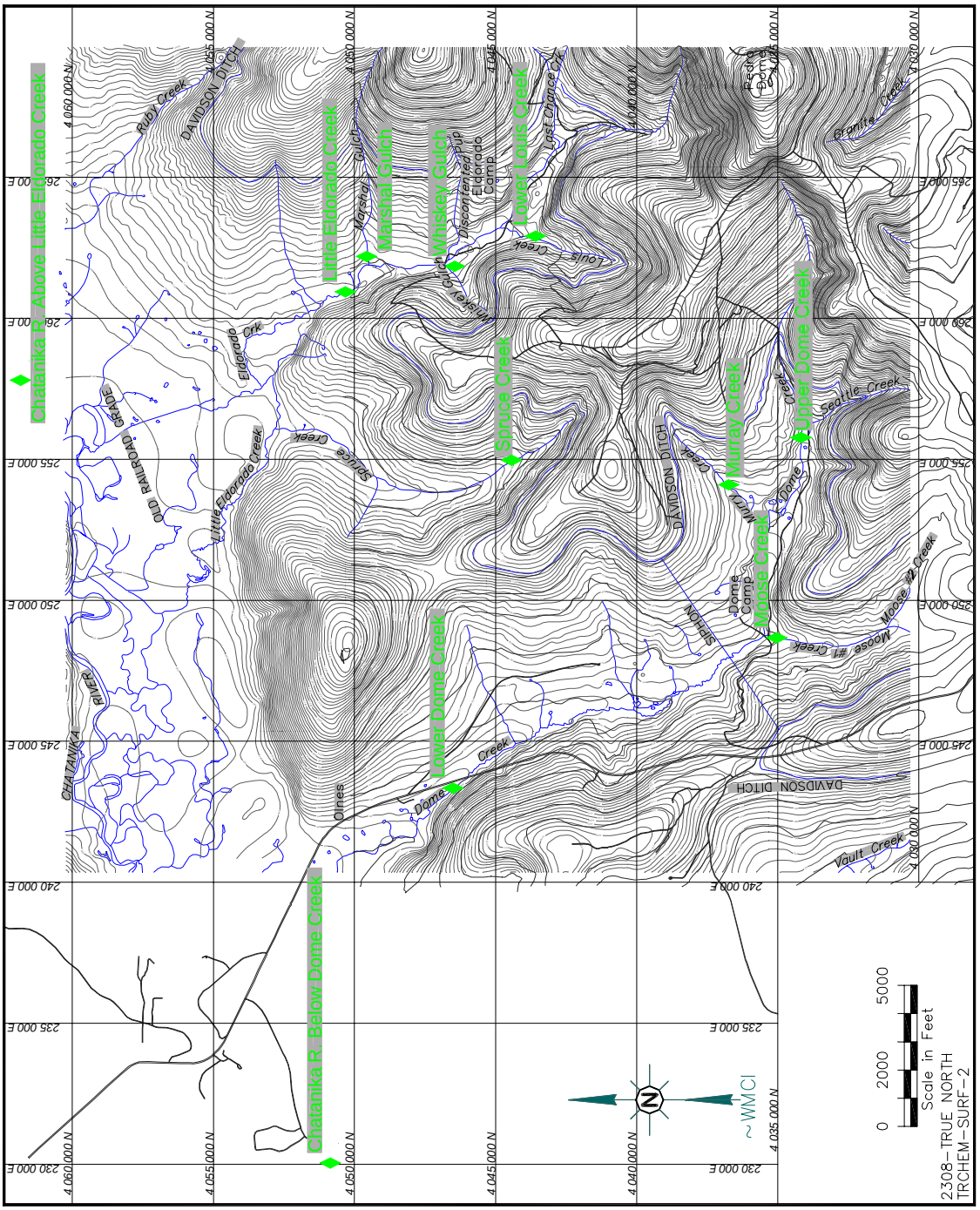

Table 3.7-2

Summary of surface water sampling events

Drainage	Location	Sampling events	No. of events
Chatanika River	Chatanika River below Dome Ck	9/20/96, 1/19/97 (2), 5/8/97 (3), 9/26/97, 9/22/99 (1)	5
	Chatanika River above Dome Ck	9/28/98	1
	Chatanika River above LEC	10/13/96, 5/9/97 (3), 10/8/97, 9/28/98, 9/23/99 (1)	5
North Fork Little Eldorado Ck	Upper Louis Creek	9/16/94, 9/27/95, 9/20/96, 5/6/97 (3)	4
	Lower Louis Creek	9/16/94, 9/26/95, 9/20/96, 5/7/97 (3), 9/26/97, 9/23/99 (1)	6
	Whiskey Gulch	9/16/94, 9/26/95, 9/24/96, 5/7/97 (3), 9/26/97, 9/29/98, 9/23/99 (1)	
	Marshall Gulch	9/24/96, 5/7/97 (3), 9/26/97, 9/29/98	4
	Marshall Creek	9/23/99 (1)	1
	Little Eldorado Creek	10/12/99 (1)	1
	North Fork Little Eldorado Ck (LEC)	10/5/95, 9/23/96, 5/7/97 (3), 10/2/97, 9/29/98	5
South Fork Little Eldorado Ck	South Fork Spruce Creek	9/16/94, 9/27/95, 9/24/96, 5/6/97 (3), 10/7/97, 9/29/98	6
	North Fork Spruce Creek	5/6/97 (3), 10/7/97, 9/29/98	3
	Lower Spruce Creek	9/23/96, 5/7/97 (3), 10/2/97, 9/29/98	4
	Spruce Creek	10/12/99 (1)	1

Table 3.7-2 (cont'd)

Summary of surface water sampling events (cont'd)

Drainage	Location	Sampling events	No. of events
	South Fork Little Eldorado Ck (LEC)	10/5/95, 9/23/96, 5/7/97 (3), 10/2/97, 9/29/98	5
Dome Creek	Murray Creek	9/16/94, 9/27/95, 9/24/96, 11/4/96(2), 5/6/97(3), 10/1/97, 9/28/98, 9/22/99(1)	8
	Moose Creek (plus DUP)	9/28/98 (2 analyses), 9/22/99 (1)	3
	Lower Dome Creek	10/5/95, 9/23/96, 5/8/97 (3), 9/26/97, 9/28/98	5
	Dome Creek	9/22/99 (1)	1
Ruby Creek	Ruby Creek	10/8/97	1
Pedro Creek	North Fork Steamboat Creek	5/9/97 (3), 10/2/97 9/28/98	3
	Steamboat Creek	9/22/99 (1)	1
	Granite Creek	9/28/98, 9/22/99 (1)	2
Total			82

(1) samples collected by FGMI

(2) analyses limited to benzene, chlorobenzene, 1,2-, 1,3-, 1,4-dichlorobenzene, ethylbenzene, toluene, xylenes, surrogate recovery

(3) analyses limited to pH, turbidity, arsenic, conductance

na not available

3.7.2 SURFACE WATER CHEMISTRY AND AQUATIC LIFE STANDARDS

With the exception of specific parameters (fecal coliform bacteria, pH, temperature, sediment, color, and residues), water quality standards for the State of Alaska use federally promulgated water quality criteria for human health and aquatic life as found at 40 C.F.R. 131.36 (18 AAC 70.020). Table 3.7-3 summarizes the results of all 82 surface water chemical analyses and includes the number of reported analyses, the number of samples with detected concentrations, the number of analyses below the machine detection limit (MDL), the minimum concentrations, the maximum concentration, and the average concentrations. The average concentration uses one half the detection limit for values reported as below the MDL (WMCI, 2000).

Table 3.7-3 includes the Alaska water quality criteria and the EPA national recommended water quality criteria (EPA, 1998). The State has adopted EPA's water quality criteria with additions of their own as the standards for water of the State. The Chatanika River is a tributary to the Tolovana River and eventually joins the Tanana River. The Chatanika River is protected for use as water supply for agricultural, aquacultural, and industrial use, for water recreation, and for growth and propagation of fish, shell fish, other aquatic life, and wildlife (designated classes (1) (A), (1) (B), and (1) (C)). The water quality criteria used for this comparison are the criterion continuous concentration (CCC, or chronic aquatic life standards) for both priority and non-priority pollutants and are reported in µg/L, except for pH (units) and temperature (°C). The chronic water quality have been used in the comparison of background to standards as they represent toxicity over the long term. The total number of exceedences for each analyte also are included in Table 3.7-3. The criteria for cadmium, copper, lead, nickel, and zinc are dependent upon the specific hardness of the water and therefore only the formulae are reported in Table 3.7-3 (WMCI, 2000).

Measured concentrations exceeding the applicable standards were noted for alkalinity, copper, iron, lead, nickel and pH. The exceedences reported for alkalinity stem from the very low criterion for alkalinity of 20 mg/l. The

exceedences(s) for copper (one dissolved and five total recoverable analyses) range from less than 0.02 to 0.05 mg/l, for lead (one dissolved and one total recoverable analysis) range from 0.004 to 0.008 mg/l, and for nickel (one total recoverable analysis) WAS 0.035 mg/l. Two pH values of 6 and 6.2 are below the water quality criteria of 6.5 and 28 total iron analyses exceeded the water quality criterion of 1 mg/l (WMCI, 2000).

3.7.3 GROUNDWATER QUALITY

Baseline groundwater samples have been collected from nine wells in the True North project area since 1994. Three of these (TN-182, 281, and 672) are exploration boreholes drilled and sampled by Newmont Mining, and six (MW-2, 3, 6, 7, 8, and 9) are monitoring wells drilled by FGMI in 1999. The locations of these wells are shown on Figure 3.7-2.

Sixteen groundwater samples were collected from these historic and active monitoring wells. Table 3.7-4 summarizes the sampling events. Annual groundwater samples were collected by Newmont from 1994 through 1998. FGMI continued the sampling program in 2000 using the newly installed monitoring wells.