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TECHNICAL MEMORANDUM

TO: Bob Kirkpatrick – Northern Region
Mary Beth Marks – On-Scene Coordinator

FROM: Allan Kirk – Senior Project Geologist

DATE: January 10, 2003

RE: McLaren Adit Assessment
New World Mining District Response and Restoration Project

INTRODUCTION

The McLaren Adit (Winter Tunnel) is located at the northwest end of the McLaren Pit on the west flank of Fisher Mountain (Figure 1). As part of the overall New World Response and Restoration Project, the McLaren Adit was proposed for re-opening in 2001 in order to conduct a visual assessment of the extent of mine workings, and to make a preliminary assessment of water in-flows and water quality prior to designing and constructing a long-term adit closure.

As described in the 2001 Work Plan (Maxim, 2001), the portal of the adit was to be opened, and, if the workings were easily accessible, geologic mapping and water quality sampling would be conducted to determine if the geology, geologic structure, or water inflow might be significant with respect to design of an overall closure plan. No major mine rehabilitation activities were proposed to clear the underground workings.

This memorandum summarizes the activities conducted at the McLaren Adit during 2001 and 2002. Maxim Technologies, Inc., conducted the activities with assistance from Henry Bogert, Pony Mining Contractors, the USDA Forest Service, and the URS construction group. All activities were conducted in accordance with the 2001 and 2002/2003 Work Plans (Maxim, 2001; 2002).

SETTING OF THE MCLAREN ADIT (WINTER TUNNEL)

In 1933, the McLaren gold-copper-silver mining operation was developed on the west side of Fisher Mountain (Figure 1). Initial mining and exploration was conducted from a series of six, east-northeast trending adits of varying lengths. Five of these adits are shown on McLaren Gold Mine maps of 1937 and 1947. The sixth adit, called the Winter Tunnel (or the McLaren Adit), does not appear on maps until 1952 – one year prior to the cessation of open-pit mining. The geometry of ore exposed in the early exploration adits indicated that the ore in the McLaren Mine was laterally extensive, tabular-shaped, and dipped gently to the southwest. It was determined that the McLaren gold-copper-silver deposits could

be most efficiently mined by open-pit methods. In subsequent open-pit mining operations, waste rock was stripped from above the underlying massive sulfide ore, and stockpiled to the north side of the pit. The massive sulfide ore was stripped down to its lower contact with an interformational dacitic intrusive sill within the Meagher Limestone host rock. Presumably, the first five adits were mined out during open-pit mining operations, although this cannot be confirmed with existing information. The sixth adit, the Winter Tunnel, is still present at the northwest end of the McLaren Pit. It may have been driven late in the McLaren Mine life in order to explore the potential for mineralization in the subsurface to the north of the existing pit.

Historic maps show only the "proposed location" of the Winter Tunnel (McLaren Gold Mines, 1952) and project the (proposed) underground workings about 400 feet northeast of the portal. Track, ties and timber at the portal and on the waste rock dump indicate that waste material was removed from the mine by rail, and therefore, the probable slope of the workings should be about 0.5-2%. The volume of material in the waste rock dump is estimated at about 3,000 cubic yards, which suggest that the total amount of workings could be as much as of 1,200 lineal feet. Twelve hundred lineal feet of workings, along the same heading, would take the tunnel well past the main Fisher Mountain intrusive contact (out of the ore and into waste) and it is therefore presumed that there must either be cross-cuts and drifts and/or stopes developed in the mine to account for the additional waste material, or waste was added to the dump from other sources. Figure 2 is a 1989 photograph showing the location of the McLaren adit and its waste rock dump (variously known as "hot hill" or the "Multicolored dump").

REOPENING THE ADIT

2001 ACTIVITIES

Maxim Technologies first reopened the McLaren Adit in September of 2001 using a track-mounted excavator. Figure 3 shows the collapsed portal of the McLaren Adit prior to reopening. The portal timber set remained in place, although the lagging across the back (roof) had collapsed to form a wooden ramp that dipped back into the mine upon which material had caved or sloughed. The portal was blocked and water was backed up essentially all the way to the back (roof), such that, under spring run-off conditions, dammed up water in the adit was forced out between the broken lagging boards above the top beam at the portal under a pressure estimated to be about 15 pounds. Assuming a 5-foot by 7-foot cross-section and a 400-foot length, there could have been as much as 100,000 gallons of water stored under a hydraulic head within the mine. Historically, degraded water flows year-round from the portal at rates that range from two to almost 30 gallons per minute (gpm). Broken and collapsed ferricrete deposits overlying a collapsed portion of the adit immediately to the northeast of the portal timber set showed evidence of collapse to surface (Figure 2). This area of collapse was excavated first and water pumped (Figure 2) from behind the adit portal dam so as not to risk a complete breaching of the portal dam and a release of stored water.

Two settling ponds or basins were constructed downgradient of the portal prior to draining the workings. The furthest downgradient pond lies immediately adjacent and to the north of the waste rock dump. The dam for this pond was constructed with a rock core and uphill face of coarse talus material and was lined with a filter fabric. The dam was about 20 feet long and three feet high and covered an area of approximately 400 square feet. The outlet to this pond was a 6-inch HDPE pipe that discharged into the tributary that previously received water drained from the mine workings.

The uphill drainage basin or settling pond was constructed immediately outside of the mine portal, uphill of the main access road and a 16 inch steel culvert drained the workings under the road to the lower settling pond. This pond was excavated a total of about 15 feet deep and just into bedrock to allow for maximum settling of sediments discharged from the mine. This basin was not lined and had a natural overflow or spillway at grade that led to the lower pond.

Once the sediment ponds were constructed, the collapsed portal was opened from above, and water was pumped into an adjacent drainage channel. Once the water level dropped a few feet, the portal dam was breached, and the collapsed material slowly lowered in elevation to drain the remainder of water from the mine.

Allan Kirk and Henry Bogert entered the Winter Tunnel on September 18, 2001 to explore the workings and look for sources of water inflow. The tunnel has continuous timber sets for a distance of about 100 feet with lagging in the back and sidewalls. The mine is open from this point for a distance of about 300 feet, where there is a slough or cave about five feet high that dams water. An oxygen meter indicated that oxygen levels were depleted to 19.5%, a level that the Mine Safety and Health Administration (MSHA) deems unsafe for workers without supplied air. From the slough or cave at 300 feet, the next approximately 100 feet of workings were visible, at which point there was another slough or cave.

No water sources (other than an occasional drip) were observed in the first 300 feet of workings, and water was flowing over the slough or dam at 300 feet. Based on the fact that the mine flowed year-round, it was assumed that a significant inflow must occur at some point further into the mine.

Since it was likely that air quality in the workings would improve by natural convection over the winter, access to the deeper portions of the mine would be attempted in early summer of 2002. The area around the portal was cleaned up and a plywood portal closure was constructed for the winter.

Water quality was monitored at the mine's drainage channel confluence with Daisy Creek (Surface Water Sampling Site DC-2). There was only one short period that exceeded the turbidity standards in Daisy Creek during the dewatering event.

2002 ACTIVITIES

During the winter of 2001/2002, a rock fall and slump of overlying material at the portal of the McLaren Adit, resulting in reflooding of the mine (Figure 4). The mine was reopened in September of 2002, again using a tracked excavator. Two additional and much larger settling ponds were excavated below the waste rock dump at the McLaren Adit, such that there was now a string of four settling ponds that flowed one into the other. Outfall from the lowest pond discharged into the drainage channel that had previously drained the mine workings. The mine was drained by gradually excavating (lowering) the dam at the portal. Once the mine portal was completely excavated and the mine drained (about three days), three 8-inch by 10-foot sections of PVC sewer pipe were joined and laid in an excavated ditch along the south side of the adit sill (floor) through the portal and extended about 22 feet out in front of the portal for drainage. An oval-shaped 4 foot diameter and 20 foot long steel culvert was placed in the portal such that it slipped about 3 feet inside the portal timber set and extended about 17 feet outside of the portal (Figure 5). This culvert was installed to provide safe access to the mine and prevent any future collapses in the vicinity of the portal from closing the mine.

Preliminary reconnaissance indicated that air quality in the workings had indeed improved over the winter, so a two-man mining crew (Pony Mining Contractors) was brought in to clear the internal sloughs and establish drainage in preparation of assessment of the underground workings.

UNDERGROUND WORKINGS

In mid-September of 2002, after the underground workings were cleared, drained, and made accessible by Pony Mining Contractors, Allan Kirk and Henry Bogert reentered the adit and mapped the mine (Figure 6). In total, 423 feet of workings were accessible. The adit is one straight heading that was driven at a bearing of N. 22° E. The first 104 feet of the adit are timbered and lagged in both the back (roof) and ribs (sidewalls). The adit is driven in rock with no timbering from 104 to 334 feet, where a slough consisting of rock fall material approximately five feet deep crossed and blocked the adit. Water was dammed up approximately 4.5 feet deep behind the slough. The sloughed material had fallen from a bald-headed raise that extends up about 30 feet from the left rib (side wall) (Figure 6). The raise is timbered into stalls above the adit level. The slough at this location was trenched and the water drained by Pony Mining. The adit from 334 feet to 423 feet, the end of the accessible workings, was timbered and lagged across the back of the workings. Two minor sloughs were also located just past the raise. At the end of the workings there is a major slough or cave-in that has stoped upward about 12-feet into the back of the workings. The debris has fallen to the sill (floor) and completely blocks access to additional workings if they are present.

The portal of the adit is collared in a mix of altered and mineralized Meagher Limestone, and Dacite porphyry of Lulu Pass, both of which are unconformably overlain by ferricrete deposits. In this area, the Dacite porphyry of Lulu Pass occurs exclusively as an intrusive dike along the Crown Butte Fault, and based on mapping and geologic evidence from adjacent drill hole data, the Crown Butte Fault does in fact cut across the portal area of the McLaren Adit. The remainder of the adit is driven in the Meagher Limestone for the entire length examined, except for the presence of a few thin sill-form intrusives of the Fisher Mountain Porphyry (Figure 6). Sulfide-rich replacement mineralization (20-30% sulfides) in limestone rock is present in the north rib at the portal and is exposed in the lower three feet of the workings to 280 feet, where a thin, intrusive sill enters the limestone section and the degree of sulfide replacement mineralization increases to about 60% sulfides in limestone both above and below the sill throughout the remainder of the workings.

PRESENT WATER INFLOW TO THE WORKINGS

In 2001, water depth at the portal was about two feet prior to installation of the drainage pipes. At 222 feet, the railroad ties are exposed above the water level in the sill (floor) of the adit, indicating a 0.5% slope to the adit, which is consistent with a tracked-access mine. The adit portal was flowing at a rate of about three to four gallons per minute (gpm) during this examination, and approximately the same amount of water was overflowing the slough and dam at 334 feet. No water sources between the portal and the first slough were observed.

In 2002, during a synoptic sampling event on September 26, water flow from the portal was measured at 6.9 gallons per minute (Table 1). Only two inflows to the mine were identified during mapping, one occurs at 366 feet and the other is a flow through the slough at the most distal end of the accessed

workings (423 feet, Figure 6). The inflow at 336 feet comes from a source in the back (roof) near the right rib (side), which clearly originates from a 4.25-inch borehole that penetrates the workings. This borehole diameter suggests it was a reverse circulation drill hole, and in fact a pile of drill cuttings was present on the sill beneath the drill hole. The location of this drill hole was back surveyed from the portal of the adit on the surface to the approximate collar location. Crown Butte Mines drill hole location maps were examined and the hole was determined to be a vertical reverse circulation drill hole numbered 90-518. The log of the drill hole is presented as Figure 7. This drill hole log indicated that it penetrated a void from 130 to 140 feet below the surface. The void was located in massive sulfide mineralization in association with a sill of the Fisher Mountain porphyry. The hole continued on to a total depth of 160 feet, encountering the Meagher Limestone / Wolsey Shale contact at 152 feet. This is clearly the drill hole that penetrates the working in the McLaren adit.

Table 1
McLAREN ADIT GROUNDWATER INFLOW AND TOTAL OUTFLOW
(synoptic sampling 9/26/02)
New World Mining Response and Restoration Project
McLaren Adit Technical Memo

Distance from the Portal (ft)	Flow in gpm	Percent of Total Flow
0	6.9	100
366	5.5	79
423	1.46	21

Water flow from the drill hole at 366 feet in the workings (Figure 6) was measured at 5.5 gpm (Table 1) during the synoptic sampling event on September 26 (Table 1). The other water inflow, located at the most distal part of the workings (423 feet), is from water coming over and through the sloughed material. This flow becomes channelized as it flows across the slough and was measured at 1.46 gpm (September 26th) (Table 1).

HISTORICAL WATER OUTFLOW FROM THE WORKINGS

Water outflow from the McLaren Adit has been sporadically measured (about 20 times), principally in the summer months (July through September) since 1989 (Table 2). The outflow has ranged from 1.8 to 29.6 gpm with an average value of 13 gpm. Figure 8 is a graph showing seasonal water flow from the McLaren adit by plotting average flow volume for two-week intervals of time, plotted against time. The distribution of flow volume is clearly seasonal (Figure 8), and likely related to groundwater recharge by snowmelt followed by subsequent drain down.

WATER QUALITY

Water quality data from historical outflows is presented in Table 2. Historical water quality data show a range of pH from 2.8 to 7.2 standard units (s.u), with all but one measurement greater than a pH of 5.8 s.u (one value of pH at 2.8 that was measured in 1989 is considered questionable with respect to the other values measured, but it has been included in the average calculated). Metal concentrations have been measured for aluminum, arsenic, cadmium, copper, iron, manganese, lead, and zinc (Table 2). Maximum, minimum, and average values have been calculated for the historical concentrations of these metals (Table 2). Data presented in Table 2 is for total recoverable metal concentrations, except where noted by a small letter "d" for dissolved metal values. Exceedances of the chronic aquatic water quality standards (MDEQ, 2000) are common for aluminum, total recoverable copper, iron, and manganese, and occur for one out of twenty samples collected for cadmium and dissolved copper (Table 2).

Water quality collected from the portal (D-18-0, Table 2) and the two underground inflows at 366 feet (D-18-366) and 423 feet (D-18-423) are presented from a synoptic sampling event on September 26 of 2002. Only dissolved metal concentrations were measured in these samples. Water quality standard exceedances occur for iron and manganese in all samples with the sample at the back of the mine (423 feet) having the highest concentrations. The copper standard is exceeded only in the sample collected from the borehole.

Table 2.
McLAREN ADIT WATER QUALITY DATA
New World Mining District Response and Restoration Project

		Flow	pH	Total Recoverable Metals (milligrams per liter)								
Site	**Date**	**(gpm)**	**(su)**	**Al**	**As**	**Cd**	**Cu(d)**	**Cu**	**Fe**	**Mn**	**Pb**	**Zn**
D-18	09/13/1989	1.8	2.8	-	-	-	-	-	-	-	-	-
D-18	07/13/1990	25	7.2	0.2	<0.005	0.001	-	0.01	13.8	0.91	-	0.09
D-18	07/25/1990	20	6.7	<0.1d	<0.005d	0.0001d	<0.001	-	0.03d	0.91d	0.004d	<0.01d
D-18	08/01/1990	23	6.5	<0.1	<0.005	<0.001	-	<0.01	17.5	0.86	<0.01	0.03
D-18	08/22/1990	18	6.3	<0.1	<0.005	<0.001	-	<0.01	17.3	0.88	<0.01	0.03
D-18	09/06/1990	9	6.3	0.4	<0.005	<0.001	-	<0.01	22.3	0.9	<0.01	0.05
D-18	09/06/1990	9	6.3	0.4	<0.005	<0.001	-	<0.01	21.8	0.85	<0.01	0.05
D-18	09/25/1990	6.5	6.4	<0.1	<0.005	<0.0001	0.001	0.002	19.2	0.93	<0.002	0.06
D-18	07/10/1991	17.6	6.4	0.9	<0.005	0.0049	0.012	0.08	14.7	0.86	0.0	0.05
D-18	09/25/1991	6.8	6.7	0.2	<0.005	0.0017	0.001	0.018	14.6	0.94	<0.002	0.03
D-18	09/25/1991	6.8	6.6	0.2	<0.005	0.0008	0.002	0.012	14	0.83	<0.002	0.03
D-18	07/20/1995	20.1	6.1	1.3	0.004	0.0005	0.023	0.078	14.4	0.62	0.006	0.028
D-18	09/26/1995	5.6	5.9	0.2	<0.001	0.0008	0.002	0.011	24	1.07	<0.002	0.028
D-18	07/10/1996	18	6.6	0.3	-	0.0004	0.014	0.045	9.9	0.534	<0.003	0.02
D-18	09/10/1996	6.7	6	0.2	-	0.0009	<0.001	0.005	29.2	1.14	<0.003	0.04
D-18	10/05/1996	3.1	6	0.1	-	0.0006	<0.001	0.003	27	1.1	<0.003	0.02
D-18	10/05/1996	-	-	<0.144d	<0.005d	<0.002d	<0.007	-	26.6d	1.08d	<0.002d	<0.0326d
D-18	07/06/2001	8	6.4	0.2	<0.003	0.0017	0.017	0.026	20.8	1.04	<0.001	0.01
D-18	07/02/2002	29.6	7	<0.1	-	<0.0001	-	0.017	6.69	0.49	0.001	0.02
	min	1.8	2.8	0.1	0.001	0.0001	0.001	0.002	6.69	0.49	0.0	0.01
	max	29.6	7.2	1.3	0.005	0.0049	0.023	0.08	29.2	1.14	0.01	0.09
	mean	13.03		0.31	0.004	0.001	0.01	0.02	17.95	0.87	0.004	0.04
Standard*				0.087	0.018	0.0025		0.0093	0.03	0.05	0.0032	0.12
D-18-0	09/26/2002	6.9	6.9	<0.1d		0.0003d	<0.001		7.39d	1.00d	<0.001d	0.02d
D-18-366	09/26/2002	5.5	7.5	<0.1d		0.0051d	0.019		2.13d	0.65d	<0.001d	0.04d
D-18-423	09/26/2002	1.46	6.5	<0.1d		<0.0001d	<0.001		25.7d	1.28d	<0.001d	0.03d

d = dissolved value, not included in average su = standard units gpm = gallons per minute
* = chronic aquatic life standard (MDEQ, 2002); shading indicated exceedance of standard.

METAL LOADING

Table 3 presents metal loading calculations for iron and manganese from the McLaren Adit. The total load calculated for iron from the portal is 0.282 kilograms per day (kg/day) and for manganese is 0.038 kg/day. Of the total iron load, 22.7% comes from the borehole (D-18-366) and 72.5% from the sample site at the end of the mine (D-18-423). These numbers are 51% and 26.7% respectively for manganese.

Table 3
SELECT METAL LOADING FROM THE McLAREN ADIT
New World Response and Restoration Project
McLaren Adit Technical Memo

Metal	Sample Site	Flow (gpm)	Flow (l/sec)	Conc (mg)	Load (mg/sec)	Load (Kg/day)	% of Total Load
Fe	D-18-0	7.00	0.441	7.39	3.26	0.282	
	D-18-366	5.50	0.3465	2.13	0.74	0.064	22.65%
	D-18-423	1.46	0.09198	25.7	2.36	0.204	72.53%
Mn	D-18-0	7.00	0.441	1	0.44	0.038	
	D-18-366	5.50	0.3465	0.65	0.23	0.019	51.07%
	D-18-423	1.46	0.09198	1.28	0.12	0.010	26.70%

TEMPORARY CLOSURE

In October, when the McLaren Adit was closed for the 2002 season, three water flow control measures were in place inside the mine. At the back of the mine, a five foot section of 8-inch PVC pipe was left embedded in the slough at the distal end of the mine (423 feet). This pipe was installed to assist with past and future water flow volume measurements and was also left in place to minimized erosion on the face of the slough. At the main slough beneath the raise a 35-foot section of 15-inch of PVC culvert was placed in a trench excavated to the sill (floor) level. The culvert is corrugated on the outside with a smooth bore on the inside. The uphill end of this culvert terminates under a timber-protected section of the workings near the flowing borehole. A 45^{o} elbow and a 5-foot riser, both of which were extensively perforated with 1-inch drill holes, were connected to the horizontal portion of the culvert located near the borehole. This drainage pipe was placed on the sill through the area of previous sloughs to permit drainage through the area in the event of future sloughing should block the adit. The perforated riser was attached to assure drainage from various elevations behind the sloughed area. Finally, at the portal, the thirty-foot section of 8-inch PVC sewer pipe was left in place beneath the large diameter portal culvert to insure drainage at the sill level in the event of future collapse or rock fall at the portal.

LONG-TERM CLOSURE OPTIONS

Water flow data from the relatively low-flow synoptic sampling event indicate that approximately 79% of water from the McLaren Adit could be eliminated by effective closure of the borehole at 366 feet (Table 3). A reduction in flow of this magnitude would significantly reduce the metal load from the adit portal by about 22.6% (0.06 kg/day) for iron and 51% (0.2 kg/day) for manganese. Based on this analysis, closure of the borehole by grouting, either by surface or underground methods would seem to be a

desirable closure action. In order to grout the borehole from the surface, the collar of the hole must be located. Most reverse circulation holes were drilled from the center of the road and survey coordinates for the borehole exist.

If the borehole were grouted, it would be desirable to backfill a portion of the adit (20-30 feet) in order to provide long-term ground support in the vicinity of the borehole. It is envisioned that this could be hand placed rock if it were backfilled from underground or cemented backfill could be placed behind a form constructed in the adit and the backfill pumped from the surface during grouting of the borehole. In either case, it may be desirable to leave the PVC culvert installed in the vicinity of the raise in place to provide a long term drainage pathway for the remaining outflow from the back of the mine. Alternatively, it may be desirable to place a water-tight adit plug and/or portal plug if it is deemed necessary to attempt to shut off all of the flow from the adit.

At the portal, it is recommended that the portal be closed with a coarse rock barrier. Once the large diameter culvert at the portal is removed, coarse rock could be place as a barrier and a drainage pathway by a tracked excavator (with only minor hand work). This barrier could be extended from the existing portal toward the waste rock dump to provide a continuous drainage pathway out to a point where the rock barrier becomes part of the final grade of the reclaimed surface. It is suggested that reclamation of the portal area be integrated with the reclaimed McLaren Pit closure.

Effective closure could best be implemented if this work were undertaken during the summer of 2003. This is because the grouting crew and equipment will be at work in the Como Basin during the summer of 2003, and could easily be mobilized to grout the borehole either from underground or from the surface. This may add to the overall Glengarry closure contract. Ground support material could be placed at any time, but if it were to be composed of a cemented backfill, it could be placed (pumped) by the same crew and equipment. Finally, the rock barrier at the portal would be best constructed while equipment is actively working in the McLaren Pit. Again, if this were undertaken in the summer of 2003, the final surface grading, drainage control and revegetation work could be coordinated with similar work phases in the immediately adjacent McLaren Pit area.

REFERENCES CITED

Maxim Technologies, Inc., 2002. 2002/2003 Work Plan. New World Mining District Response and Restoration Project. Final. Prepared for the USDA Forest Service, July 22.

Maxim Technologies, Inc., 2001. 2001 Work Plan. New World Mining District Response and Restoration Project. Final. Prepared for the USDA Forest Service, June 25.

McLaren Gold Mines, Inc. 1952; Miscellaneous company maps and cross-sections on file in New World Repository, Gallatin National Forest, Bozeman Montana

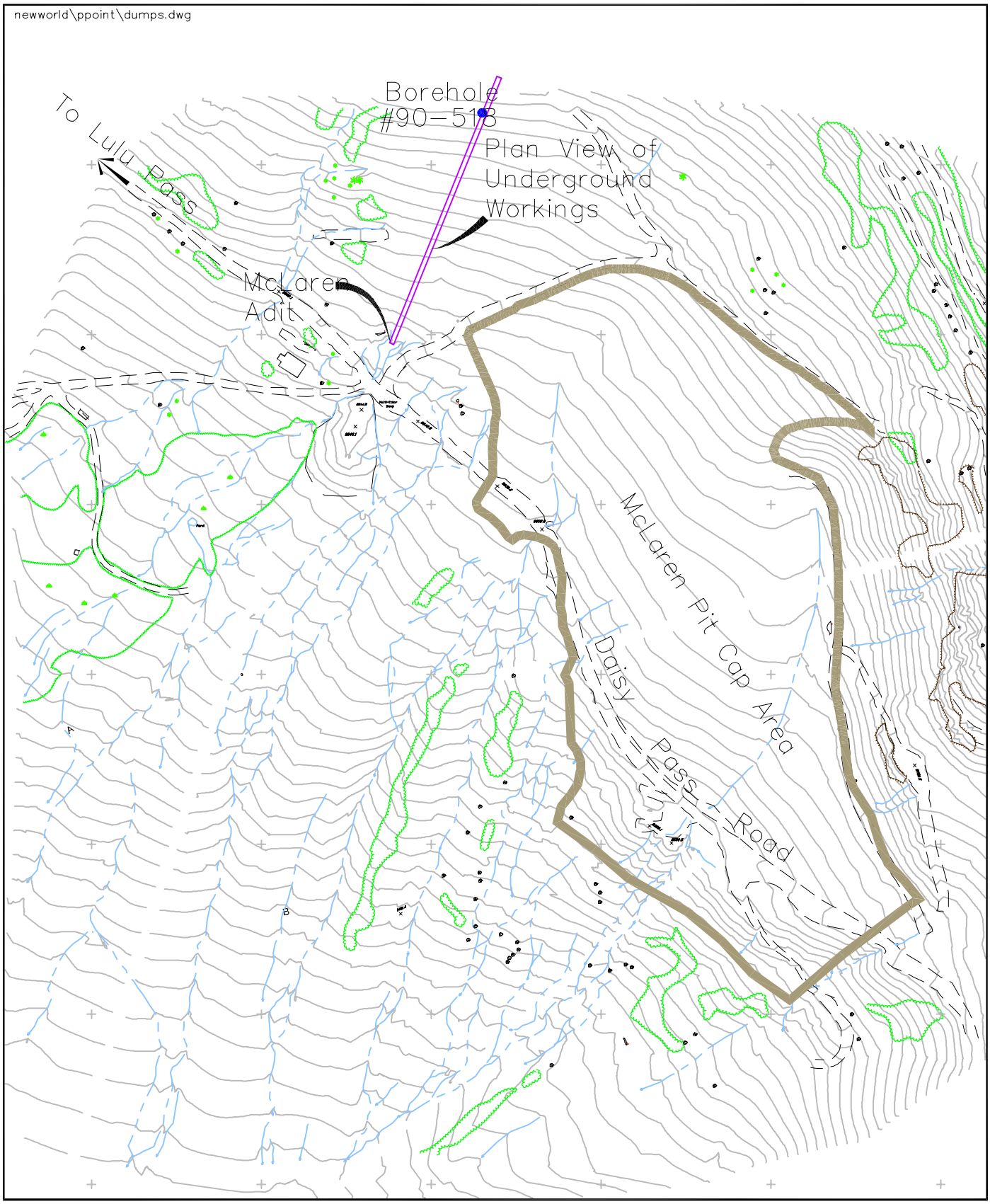
Montana Department of Environmental Quality (MDEQ). 2002. Circular WQB-7 Montana Numeric Water Quality Standards, Planning, Prevention and Assistance Division, Standards and Economic Analysis Section, January.

FIGURES

Technical Memorandum – McLaren Adit Assessment

New World Mining District Response and Restoration Project

Figure



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Location of the McLaren Adit
New World Mining District
Response and Restoration Project
Cooke City, Montana
FIGURE 1

Figure 2. McLaren Pit showing McLaren Adit and waste rock dump.

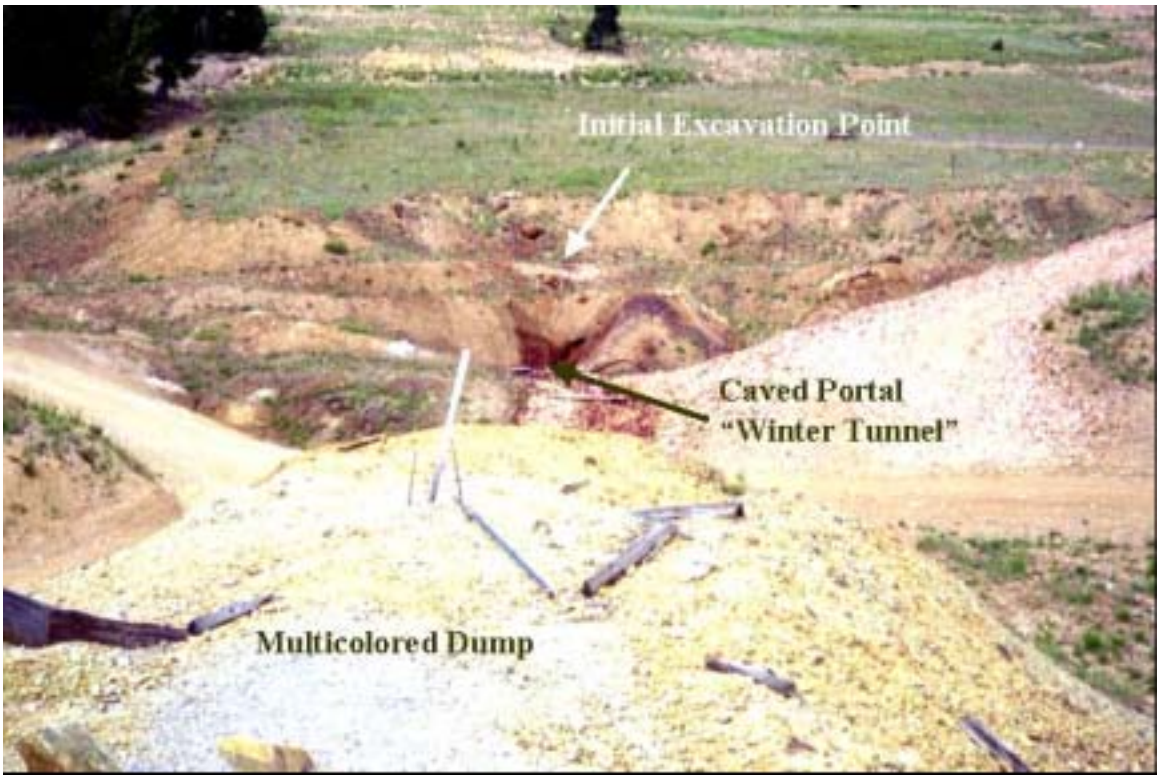
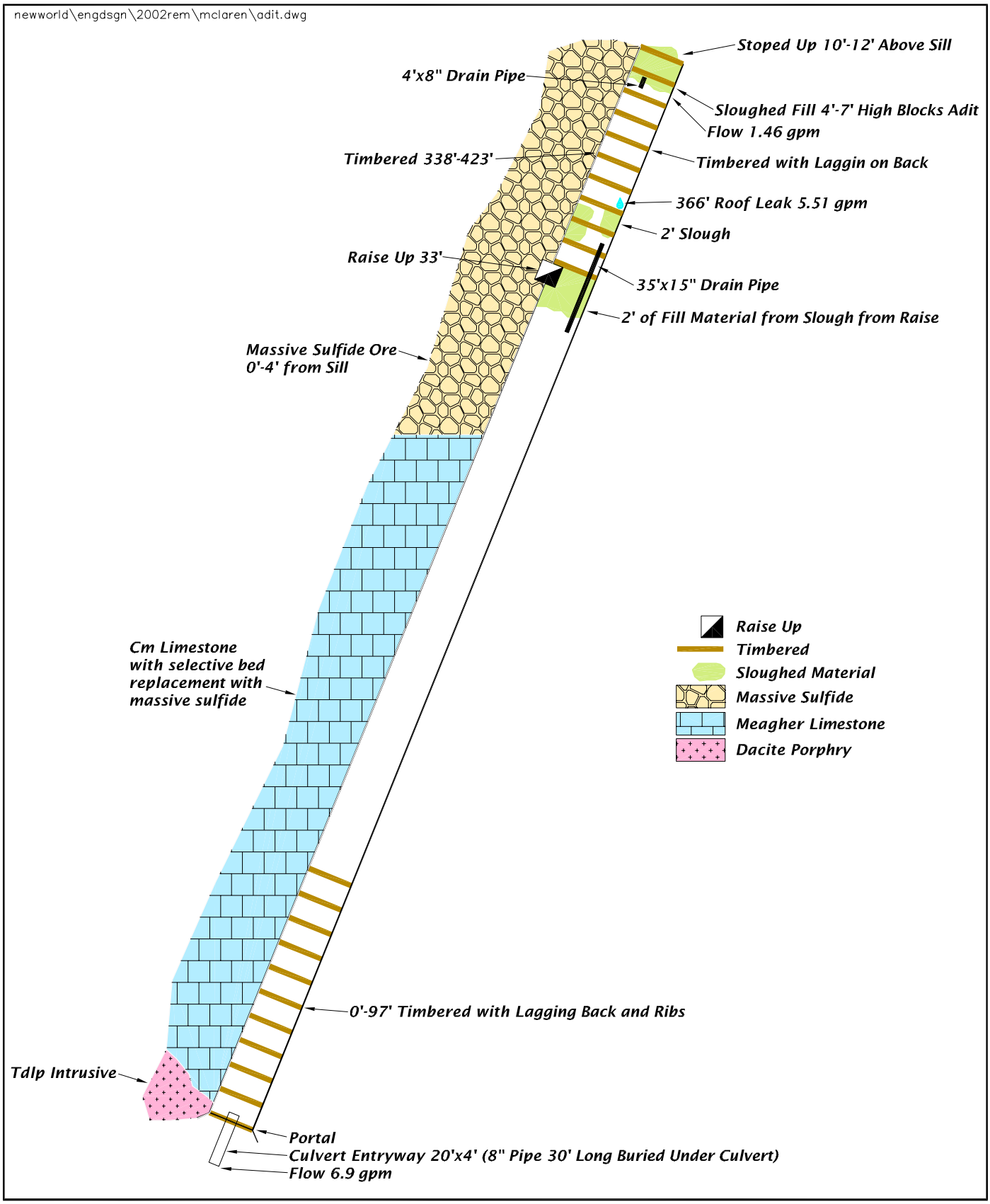


Figure 3. McLaren Adit prior to excavation in 2001.

Figure 4. McLaren Adit Portal in 2002.

Figure 5. Large diameter culvert placed in the portal.



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(Width Exagerated)

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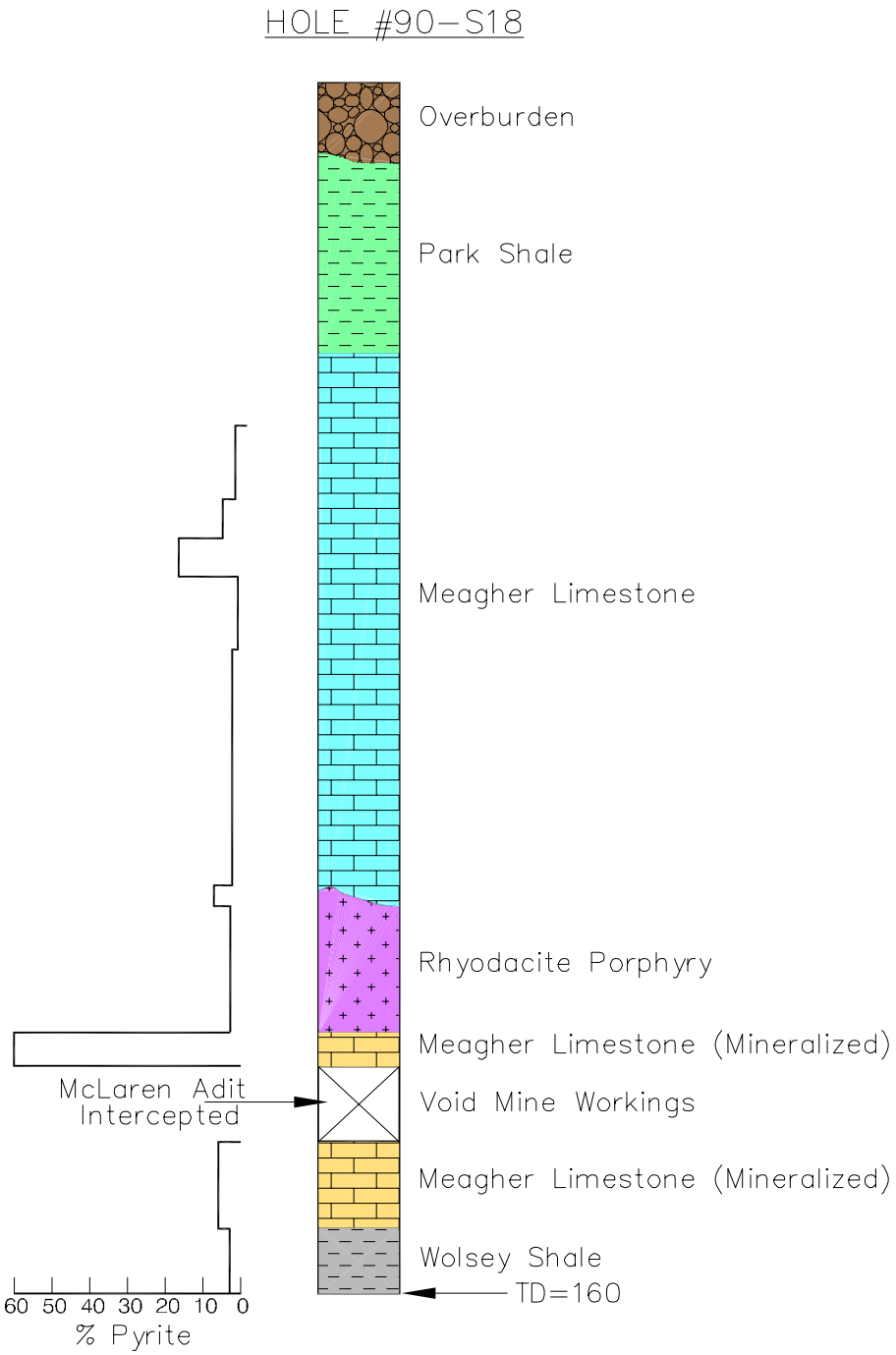
Map of the McLaren Adit
New World Mining District
Response and Restoration Project
Cooke City, Montana
FIGURE 6

newworld\ppoint\bore.dwg



Geologic Log of Borehole #90-518
New World Mining District
Response and Restoration Project
Cooke City, Montana
FIGURE 7

Not To Scale

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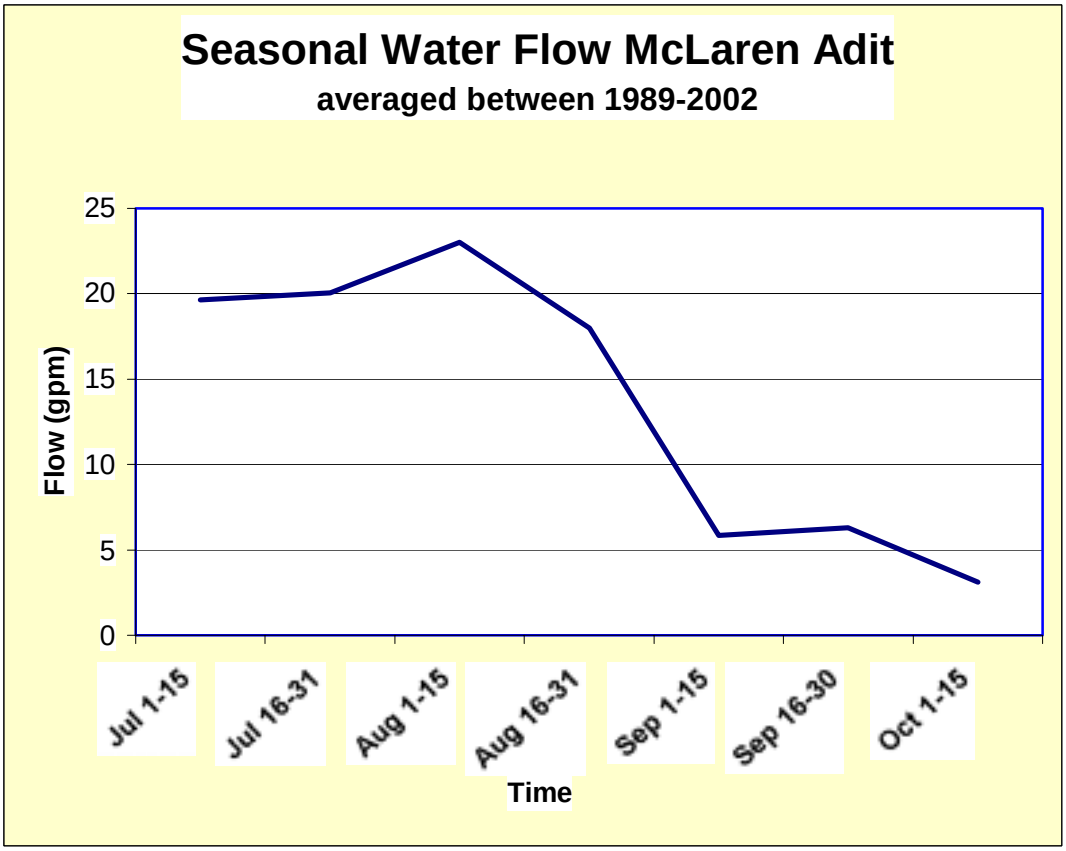

Figure 8. Seasonal water flow from the McLaren Adit.