

DELOITTE AND TOUCHE INC.
AS INTERIM RECEIVERS FOR
ANVIL RANGE MINING CORPORATION

1998 ANNUAL ENVIRONMENTAL REPORT
FOR WATER LICENCE IN89-002
VANGORDA PLATEAU

MARCH 1999

SUMMARY

Water quality monitoring was performed during 1998 in accordance with either the schedule for "normal operations" of the schedule for "temporary cessation of operations" as appropriate per Water Licence IN89-002. This report is the annual report required under Part A.9 of the Water Licence. The biological monitoring program which is required every second year was not required in 1998 and was not performed. The required annual geotechnical inspection was performed in 1998 and the full consultant report is appended here. A Performance Review of the water treatment plant for 1998 is not necessary because the plant was not operated during 1998.

Mining activities in the Grum and Vangorda Open Pits were suspended on January 28, 1998 and the shut down continued through the remainder of 1998. Known economic ore reserves in the Vangorda open pit had been depleted at the time of the shut down. In April 1998, Anvil Range Mining Corporation entered into receivership and the firm of Deloitte and Touche Inc. was court appointed as interim receiver. The minesites were under the management of Deloitte and Touche Inc. from the time of their appointment in April through the remainder of 1998.

The quantity of water entering Vangorda Creek from mine discharge locations was lower in 1998 than in previous years because the open pits were not dewatered and the water treatment plant was not operated. Water quality entering Vangorda Creek was generally within maximum allowable discharge limits with the exception of several isolated events of short duration which are described herein. Seepage water from the Grum rock dump continued, in 1998, to show no positive signs of the presence acid generation products exiting the rock dump. Run off water which accumulated in Little Creek Dam was pumped into the mined out Vangorda open pit in order to maintain an acceptable water level in Little Creek Dam.

An emergency overflow system consisting of a corrugated metal pipe buried in the dam crest which exits into a rock lined plunge pool and outlet ditch was constructed for Little Creek Dam in 1998. Engineering design was provided by the engineering firm Steffen Robertson and Kirsten Inc.

One meeting of the Technical Advisory Committee was held in 1998 at the minesite which included tours of the minesites. The primary topics discussed at the meeting included current environmental issues and on-going environmental management through the shut down period.

A reclamation work program was performed at the Vangorda rock dump by DIAND (Department of Indian and Northern Development) in 1998. Further details regarding the work program are not described herein.

A permit amendment application was outstanding at year end. The application is primarily comprised of numerous "housekeeping" issues.

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4. 1998 TECHNICAL ADVISORY COMMITTEE MEETING
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5. LITTLE CREEK POND EMERGENCY SPILLWAY, VANGORDA MINE, YUKON TERRITORY, Report No. 1CD003-01, Steffen Robertson and Kirsten Inc., December 1998

1. INTRODUCTION

1.1 GENERAL INTRODUCTION

This annual environmental report has been prepared as required by Part A Section 9 of Water Licence IN89-002 (Vangorda Plateau). This report provides water quantities used during 1998 and an interpretation of trends and variations in water quality. Anvil Range Mining Corporation entered into receivership in April 1998 and, since that time, management of the minesite has been performed by Deloitte and Touche Inc. as interim receivers. This report has been prepared by Deloitte and Touche Inc.

The biological monitoring and sediment sampling program is required to be performed every second year and was not required in 1998. The required annual geotechnical inspection was performed by Steffen Robertson and Kirsten Inc. and their full report is appended here.

Open pit mining activities were suspended on January 28, 1998 and remained suspended through the remainder of 1998. At the time when mining activities were suspended, the known economic ore reserves in the Vangorda open pit had been depleted. While active mining was underway in January 1998, ore was trucked approximately 13 km to the Faro concentrator plant. Tailings were deposited in the mined out Faro pit with only infrequent upset events discharging to the Down Valley Impoundment. Activities at the Faro site are reported separately under Water Licence QZ95-003 (formerly IN89-001).

No water was pumped from either the Grum or Vangorda open pits during 1998. Pumping was not required during January because of very low winter inflows and pumping was not required during the remainder of 1998 because of the suspension of mining activities. Therefore, there was no discharge of effluent from the Water Treatment Plant during 1998. Run off water did enter Vangorda Creek from the established minesite discharge locations.

Water quality monitoring locations are illustrated on Figures 1.1 and 1.2 and are listed on Table 1.1. Water quality analytical results for 1998 for all parameters analysed are listed in Appendix 1 with statistical summaries.

1.2 OVERVIEW OF MINE WATER MANAGEMENT SYSTEMS

The mine water management system is illustrated on Figure 1.2.

Water is diverted around the Grum pit via the Grum interceptor ditch. The interceptor ditch collects water from the slopes above the Grum Pit as well as water pumped from the deep wells along the eastern perimeter of the pit. In addition, water discharged from the water treatment plant clarification pond enters the interceptor ditch.

Water from the Grum interceptor ditch passes into two settlement ponds referred to as the Sheep Pad Ponds. A smaller pond allows for initial settlement of coarser heavier particles and for dissipation of flow energy. The main pond (Sheep Pond) provides retention time for settlement of finer particles. The Sheep Pond outflow passes into Vangorda Creek at the plunge pool above the haul road.

Dewatering of the Grum pit is accomplished in several ways. Water can be pumped from deep wells located around the eastern perimeter of the pit in an attempt to intercept groundwater prior to its entering the pit. Water pumped from these deep wells is directed into the Grum interceptor ditch. Dewatering of the underground exploration workings below the Grum pit has been performed via wells into the workings drilled from within the pit. In 1997 and 1998, some of the underground workings were intercepted by pit development and it is uncertain whether future dewatering of the underground workings will be necessary or possible. Water pumped from the underground exploration workings and any other water which accumulates in the pit is pumped to the water treatment plant holding pond prior to treatment.

Grum Creek contains water from only a portion of its' original watershed due to re-routing of surface water and interception of groundwater in the Grum open pit. A large portion of the remaining Grum Creek flow can be diverted, as necessary, towards a settlement pond referred to as the Moose Pond which is a natural swale in sandy gravelly soil bermed at the downstream end. Use of this diversion is intended to minimize suspended sediment loadings entering Vangorda Creek via Grum Creek. To date when the Moose Pond diversion has been in-place, the diverted Grum Creek water has seeped into the ground and there has been no significant accumulation of water in the Moose Pond.

Water is diverted around the Vangorda Pit via the Vangorda north east and north west interceptor ditches as well as through a diversion of Vangorda Creek. The Vangorda north east interceptor ditch passes water from the slopes to the north east of the pit into Shrimp Creek which, in turn, reports to the Main Fork of Vangorda Creek. The north west interceptor ditch diverts water from the north west slopes into a settlement/groundwater recharge basin with overflow from the basin entering the plunge pool above the haul road. Vangorda Creek is diverted around its' natural channel via a half culvert flume which discharges into the plunge pool above the haul road. Vangorda Creek is then returned into its' original channel below the haul road.

Prior to the depletion of economic ore reserves in the Vangorda open pit in 1998, the Vangorda open pit was dewatered into Little Creek Dam from which location water was subsequently pumped to the water treatment plant. Since the depletion of known economic ore reserves and during the following suspension of mining activities in 1998, the Vangorda open pit has not been dewatered and run off water which accumulates in Little Creek Dam has been pumped into the mined out Vangorda open pit in order to maintain an acceptable water level in Little Creek Dam. The run off water which accumulates in Little Creek Dam is typically non-compliant for zinc and other parameters due, in part, to the presence of surface run off and seepage from the Vangorda rock dump which enters Little Creek Dam via a dump seepage collector ditch.

The completion of mining in the Vangorda open pit due to depletion of known economic ore reserves presents several opportunities for realizing environmental protection and cost benefits during the period of filling of the Vangorda pit. These opportunities exist regardless of whether open pit mining activities are being carried out in the Grum pit or whether mining activities are suspended as was the case in 1998. The mined out Vangorda pit can be viewed as a large and secure holding pond which is best utilized to contain water which requires treatment. In this way, the need for discharge of treated effluent into Vangorda Creek for the period of filling of the Vangorda pit is eliminated.

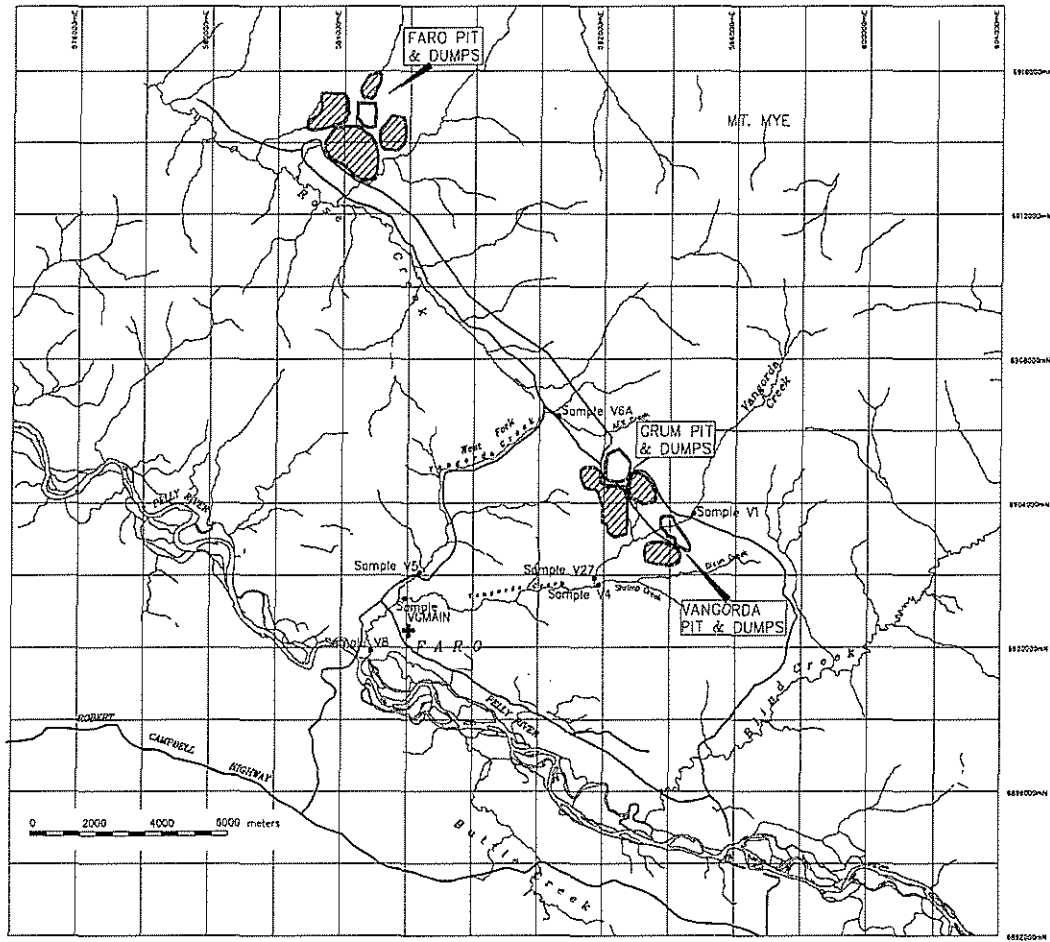


FIGURE 1.1 VANGORDA PLATEAU DRAINAGE AND MONITORING LOCATIONS

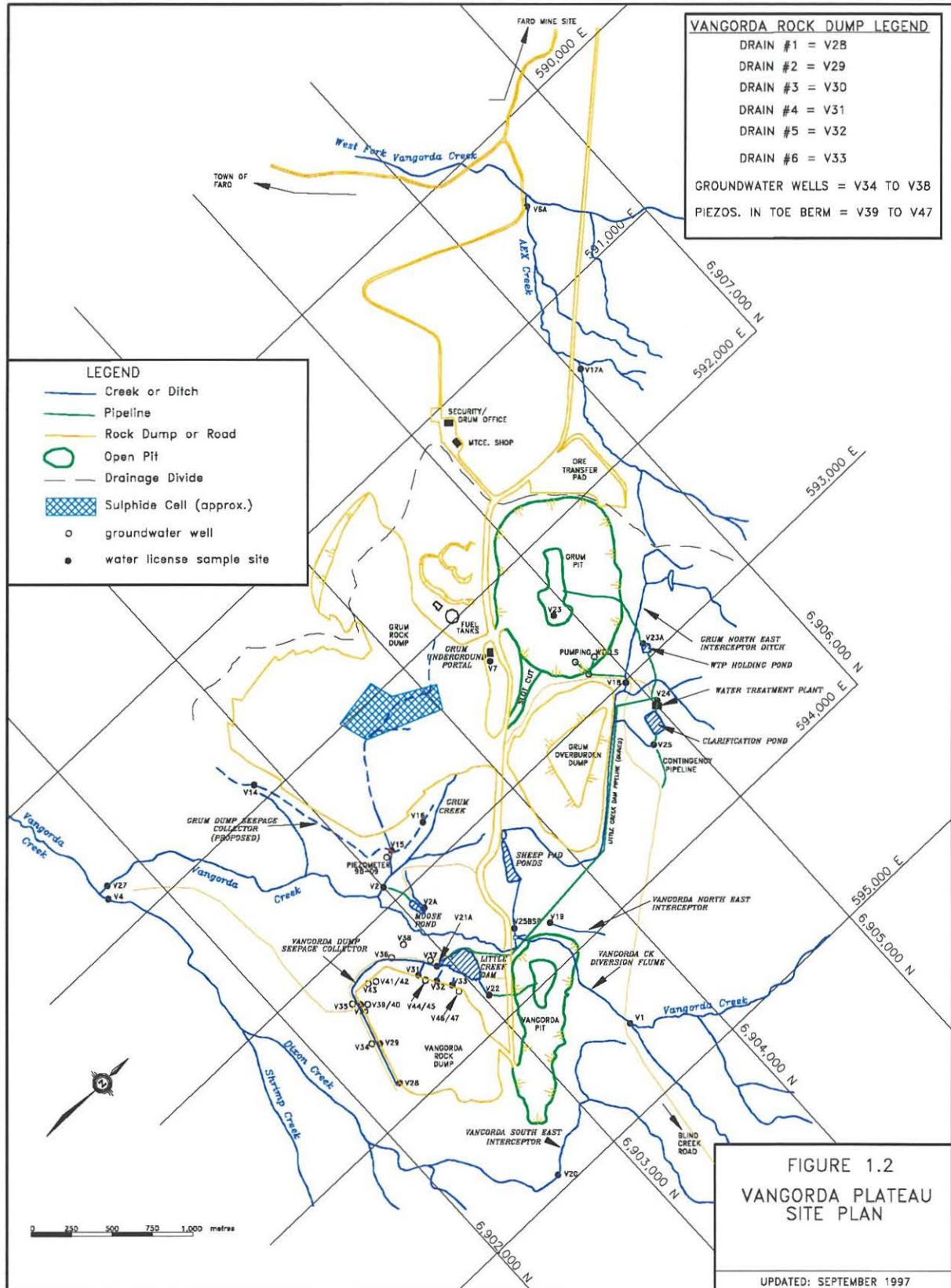


TABLE 1.1 WATER QUALITY MONITORING LOCATIONS

V1	Vangorda Creek, upstream from the mine and Blind Creek road.
V2	Grum Creek, upstream from its confluence with Vangorda Creek.
V2A	Grum Creek diversion to Moose Pond.
V4	Shrimp Creek, upstream from its confluence with Vangorda Creek.
V5	West Fork of Vangorda Creek upstream of mine access road.
V6A	A small tributary (AEX Creek) to the west fork of Vangorda Creek.
V7	Overflow from the Grum portal.
V8	Vangorda Creek near the bridge to Faro town water supply.
V14	Southwest sump Grum main waste dump.
V15	Sulphide cell sump Grum main waste dump.
V16	Southeast sump Grum main waste dump.
V17	Grum Interceptor Ditch when interceptor wells are pumping.
V17A	Surface drainage from the northern side of the Ore Transfer Pad (above the Vangorda haul road).
V18	Grum southeast interceptor ditch, when interceptor wells are pumping.
V19	Vangorda pit northwest interceptor ditch.
V20	Vangorda pit southeast interceptor ditch.
V21	Vangorda Waste Dump collector sump (middle).
V21A	Vangorda waste dump collector ditch at the discharge into Little Creek Dam.
V22	Vangorda pit water and Vangorda Lake at closure.
V23	Grum pit water and Grum Lake at closure.
V23A	Grum Pit water in the Grum external sump may be sampled in place of V23 during mine operations.
V24	Influent to treatment plant.
V25	Effluent from clarification pond outflow.
V25AF	Discharge from clarification pond discharge pipeline sampled when pipeline in use.
V25BSP	Outflow from the Sheep Pad Pond just above the Vangorda Creek plunge pool.
V26	"Little Creek" between Vangorda pit and waste dumps.
V27	Main stem of Vangorda Creek just upstream of the confluence with Shrimp Creek.
V28	Vangorda Drain #1.
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V34	Groundwater well 94GW-01 below Vangorda dump.
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V36	Groundwater well 94GW-03 below Vangorda dump.
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V42	Piezometer P-9402b on Vangorda dump berm.
V43	Piezometer P-9402c on Vangorda dump berm.
V44	Piezometer P-9403a on Vangorda dump berm.
V45	Piezometer P-9403b on Vangorda dump berm.
V46	Piezometer P-9404a on Vangorda dump berm.
V47	Piezometer P-9404b on Vangorda dump berm.

2. WATER USE

Water Licence IN89-002 permits the use of up to 3.5 million Igpd (Imperial gallons per day) or 5.8 million m³ per year of water for storage, diversion and return. In total, the water estimated for these purposes during 1998 was greater than the allowable quantity as summarized on Table 2.1. This apparent over use of water was due primarily to the volume of water flowing through Vangorda Creek which is out of the control of the mine manager.

The total water usage typically includes water passed through the water treatment plant (nil in 1998), water diverted in the Vangorda Creek diversion flume, water diverted in the Grum interceptor ditch and water pumped from the deep wells associated with the Grum open pit (nil in 1998). Water truck fill-ups from the Vangorda Creek plunge pool (nil in 1998) are not specifically included because this water will have been included in one of the other areas. Natural water flow collected in the Grum interceptor ditch is measured at location V25BSP below the Sheep Pad pond.

During the shut down in 1998, run off water which accumulated in Little Creek Dam was pumped into the Vangorda pit. There were two periods of pumping: during June/July and during October. An estimated total of 38,000 m³ of water was pumped into the Vangorda pit at an estimated pumping rate of 30 litres per second (482 USgpm). A portable submersible pump was utilized operating from a portable diesel generator.

TABLE 2.1 1998 WATER USE

Use for Storage, Diversion and Return in 1998	Estimated Quantity ('000 m³)
Vangorda Creek diversion	7,500
<u>Location V25BSP below Sheep Pad pond</u>	<u>47</u>
Total Water Use	7,547
Other Water Quantities in 1998	Estimated Quantity ('000 m³)
Pumped from Little Creek Dam into Vangorda Pit	38
Pumped from Grum perimeter deep wells	0
WTP Feed from Grum Holding Pond	0
WTP Feed from Little Creek Dam	0

3. WATER QUALITY ENTERING VANGORDA CREEK

3.1 GRUM PIT DEWATERING (V7, V17, V18, V23, V23A)

Location V7 is outflow from the underground exploration workings. There was no flow at this location during 1998 and no samples were collected.

The deep dewatering wells reporting to location V17 were not installed and, therefore, no samples were collected at V17 during 1998.

Location V18 is in the Grum north east interceptor ditch immediately below the point of entry of water pumped from a series of deep dewatering wells around the eastern perimeter of the Grum pit. The dewatering wells were not pumped during 1998 and, therefore, no sampling was required at location V18.

Nonetheless, one sample was collected at location V18 in 1998 on May 18 in order to identify freshet water quality at the upper end of the Grum interceptor ditch. This freshet sample showed a high concentration of suspended solids (150 mg/L) and elevated levels of total iron and total aluminum which were likely directly related to the presence of clayey suspended material. The sample also showed a slightly elevated concentration of total zinc at 0.07 mg/L which may also have been related to the high concentration of suspended material. The concentration of sulphate was low at only 6 mg/L. This water quality was similar to that observed during freshet 1997.

Location V23 represents Grum pit water sampled in the pit bottom. Location V23 was sampled once during September 1998 as a means of identifying water quality within the pit during the period of initial filling with water. The sample provides an indication that water quality during the initial stage of pit filling is similar to that observed during mine operations as was also observed during the temporary shut down in 1997. The September 1998 sample showed concentrations of ammonia, total zinc and sulphate which were generally within the observed ranges for Grum pit water. The concentrations of ammonia, total zinc and sulphate were 2.6 mg/L, 1.03 mg/L and 201 mg/L, respectively.

Location V23A also represents Grum pit water but is sampled at the inflow to the water treatment plant holding pond. This sampling location is useful during mine operations because it captures the combined water from various pit sumps and, prior to 1998, underground workings dewatering holes. No samples were collected at location V23A in 1998 because water was not pumped to the water treatment plant holding pond.

3.2 VANGORDA PIT DEWATERING AND ROCK DUMP SEEPAGE (V21A, V22, V26, LCD, V28-V47)

Location V21A is the discharge end of the Vangorda Dump seepage collector ditch where the ditch empties into Little Creek Dam. Flow at this location is intermittent and is usually present only during freshet. Sampling location V21A is used as a substitute for location V21 which is located near the middle of the seepage collector ditch because some seepage flow from some of the transverse drains is not present in the middle of the collector ditch. One sample was collected at location V21A during 1998 on May 18. This sample likely includes some portion of snow melt as well as dump seepage. The sample water quality showed some elevated metal concentrations including total zinc at 1.79 mg/L. The concentration of sulphate was also elevated at 435 mg/L and the concentration of total suspended solids was low at only 9 mg/L.

Location V22 is Vangorda Pit water. Following the suspension of mining activities (and dewatering) in January 1998, water which accumulated in the Vangorda open pit included both natural inflows and water pumped from Little Creek Dam. During 1998 one sample of Vangorda pit water was collected in January while dewatering activities were underway and one sample was collected in September during the

shut down. The water quality data show a marked increase in the concentrations of total zinc and sulphate from January to September from 4.88 to 42.75 mg/L total zinc and from 417 to 872 mg/L sulphate. However, the September concentrations of total zinc and sulphate were within the range observed since 1996. The concentration of ammonia decreased from January to September from 75.7 to 2.36 mg/L. However, the concentration of ammonia reported for January was atypically high. Additional timeline data is required before a confident evaluation of the water quality data may be made in terms of any trends representing longer term water quality behaviour in the filling/flooded pit.

Location V26 is a "Little Creek" between the Vangorda pit and rock dump. This location does not exist and the application for licence amendment currently under review includes the deletion of this location. No samples were collected at V26 during 1998.

Little Creek Dam is the collection point for local area run off and precipitation, surface run off from the Vangorda rock dump and toe seepage from the Vangorda rock dump. Prior to the shut down of mining activities in January 1998, the Vangorda pit was dewatered directly into Little Creek Dam and all water was pumped from Little Creek Dam to the water treatment plant for treatment and discharge. During 1998, water was pumped from Little Creek Dam into the Vangorda pit in order to maintain an acceptable water level in Little Creek Dam. Water quality in Little Creek Dam is typically non-compliant. One water sample was collected from Little Creek Dam in 1998 on May 18 which confirmed that the water was non-compliant. The sample pH was 7.0 with concentrations of sulphate, total ammonia and total zinc of 14 mg/L, 1.2 mg/L and 5.8 mg/L, respectively.

The six transverse drains which allow seepage from the Vangorda rock dump (licence monitoring locations V28 through V33) were sampled as flow allowed during 1998. As usual, no flow was observed at drain #1, flow was present in drains #2 and #4 only during freshet and flow rates at all of the drains were extremely low. Drains #2 and #4 were sampled only once during 1998 in May. Drains #3, #5 and #6 were sampled in May, June and September as flow allowed. No flow was present at any of the drains in December. In general, water quality in the drains continued to show high metal concentrations and sulphate at continued neutral pH with the exception of drain #5 where pH was in the acidic range. The water quality trends for some parameters are similar for drains #5 and #6 although water quality is poorer in drain #5. Water quality in drain #3 is generally slightly better than that in drain #6. Flows at the drains continued to be extremely low in 1998 with a maximum observed flow rate of only 0.083 litres per second at drain #3 in May. Drains #3, #5 and #6 all showed a seasonal flow trend with higher flows observed during spring.

As usual, the poorest water quality in 1998 was observed in drain #5 with peak concentrations of dissolved zinc and total sulphate of 2,180 mg/L and 10,947 mg/L, respectively, with a range in pH from 3.4 to 4.7. Flows from drain #5 were extremely low and ranged from only 0.008 Lps to only 0.03 Lps. Water quality for drain #3 may be more representative of general conditions within the dump because drain #3 most consistently has flow and because the collection area is thought to be the greatest. The peak and annual average concentrations in drain #3 during 1998 were 314 mg/L and 256 mg/L, respectively, for dissolved zinc and 2,757 mg/L and 2,676 mg/L, respectively, for sulphate with a range in pH from 5.9 to 6.1. The concentrations of dissolved zinc and sulphate for drains #3, #5 and #6 are illustrated on Figures 3.1 and 3.2, respectively.

DIAND operated a datalogger at drain #3 for approximately 2 months during August and September of 1998. The data is not included here.

Standpipe piezometers labeled GW94-01 through GW94-04 (licence monitoring locations V34 through V37) are located below the Vangorda rock dump seepage collector ditch and allow monitoring of groundwater seeping below the collector ditch. Each of these piezometers was sampled three times during 1998 in May, September and December. Piezometer GW94-05 (licence monitoring location V38) is considered damaged and is not monitored.

FIGURE 3.1 VANGORDA DUMP DRAINS

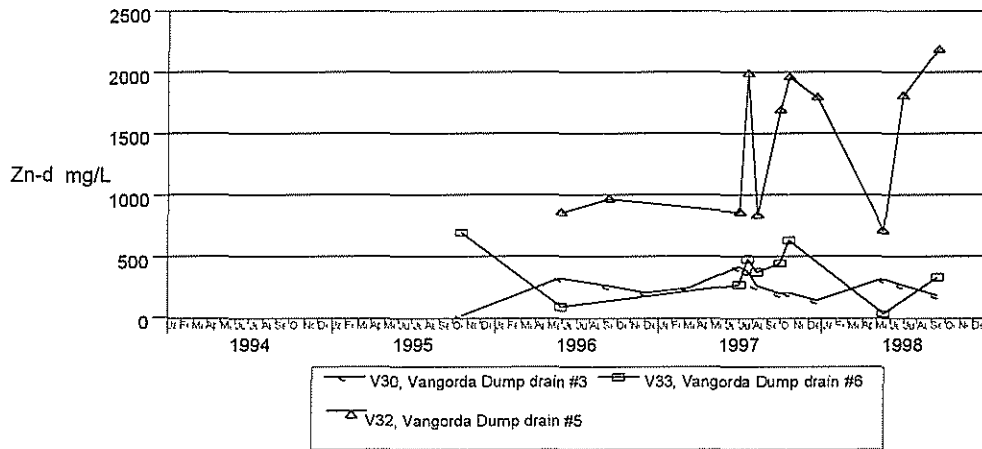
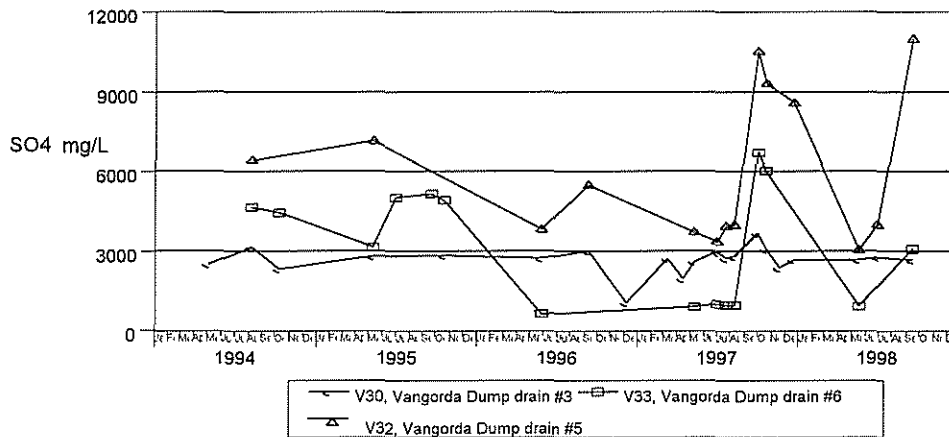


FIGURE 3.2 VANGORDA DUMP DRAINS



The water quality results for piezometers GW94-01 through GW94-04 showed no positive indications of the presence of acid generation products exiting the rock dump in 1998 although some interesting trends may be emerging. For example, irregular and aseasonal spikes in the concentration of dissolved zinc have occurred and, in each instance, all four piezometers show some brief increase with the concentration of zinc in each instance increasing from GW94-04 to GW94-03 to GW94-02 to GW94-01. However, the trend is not repeated for either sulphate or ammonia. In fact, piezometer GW94-01 typically has the lowest concentrations of ammonia and sulphate (reverse of dissolved zinc) while piezometer GW94-04 typically has the highest concentration of ammonia (reverse of dissolved zinc). The static water levels and pH for all four piezometers are generally stable. The concentrations of dissolved zinc and sulphate for piezometers GW94-01 through GW94-04 are illustrated on Figures 3.3 and 3.4, respectively.

A series of piezometers (P94-01 through P94-04) are installed in the till berm which surrounds the base of the rock dump and through which the transverse drains are intended to pass seepage water. Monitoring of these piezometers provides information regarding water pressures within the till berm and water quality. Four of these piezometers include sample tubes and also contain water on occasion and they were each sampled on two occasions in 1998. Piezometers P94-01A, P94-01B, P94-02A and P94-02C represent licence monitoring locations V39, V40, V41 and V43, respectively. Water quality in these piezometers was generally good and did not reflect the water quality observed in the transverse drains as described

above. The concentrations of dissolved zinc and sulphate in these piezometers in 1998 ranged from <0.01 to 0.04 mg/L and from 40 to 268 mg/L, respectively.

FIGURE 3.3 VANGORDA DUMP PIEZOMETERS

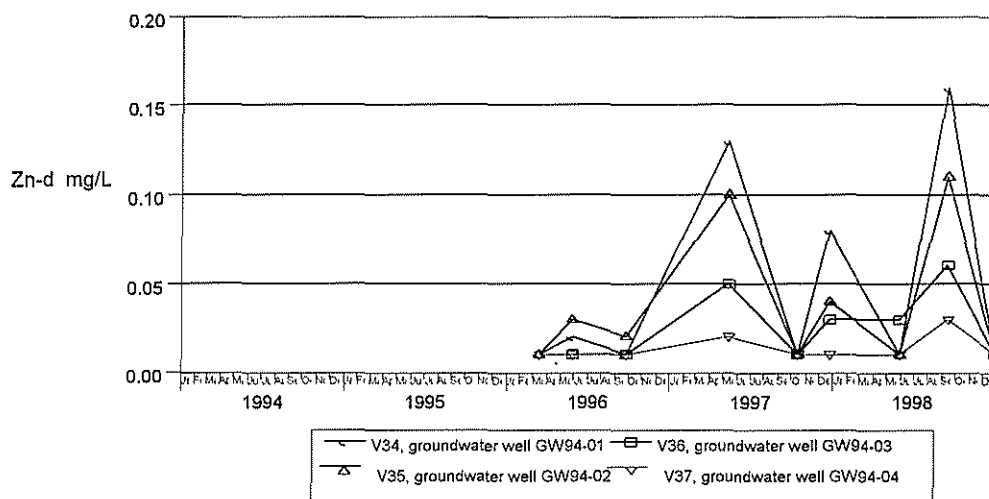
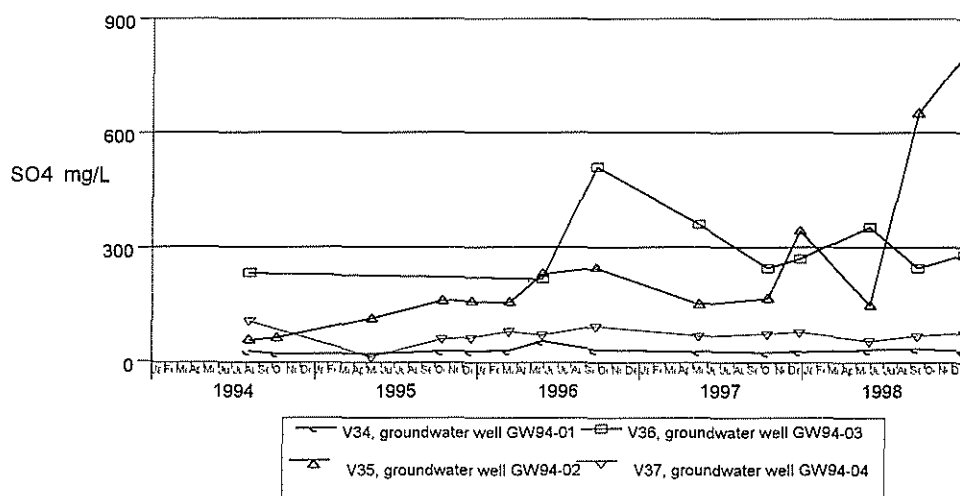


FIGURE 3.4 VANGORDA DUMP PIEZOMETERS



The geotechnical implications of static water levels recorded in the piezometers installed within the till berm (P94-01 through P94-04) are described herein in Section 6 and in the appended consultant report.

3.3 WATER TREATMENT PLANT (V24, V25)

The water treatment process consists of pH modification using lime followed by enhanced settlement of metal hydroxides with the aid of flocculant. This process does not reduce ammonia concentrations except, possibly, via retention time in the clarification pond. During periods of past mining operations, the plant has been operated on an as-required basis to maintain acceptable water levels in in-pit sumps, Little Creek Dam and the Grum holding pond.

The water treatment system was not operated during 1998. Operation of the plant was not required during January 1998 because of low flow winter conditions and operation of the plant was not required for the remainder of 1998 when mining activities were suspended because water was allowed to accumulate in the Grum and Vangorda open pits. During the summer and fall of 1998, run off water which accumulated in Little Creek Dam was pumped into the mined out Vangorda open pit as required to maintain an acceptable water level in Little Creek Dam.

Location V24 is the inflow to the treatment plant which includes water from the Grum pit via the holding pond and water pumped directly from Little Creek Dam. Location V25 is the outlet of the Clarification Pond and is sampled weekly when there is outflow. No samples were collected at either of these locations in 1998.

3.4 GRUM DUMP TOE SEEPAGE (V14, V15, V16, P96-9A/B)

Locations V14, V15 and V16 are surface seepages at the toe of the final (per design) Grum rock dump area. No flow was observed at locations V14 or V16 during 1998 and no samples were collected.

Six samples were collected at location V15 in 1998. Water quality did not give a positive indication of the presence of acid generation products exiting the rock dump. Water quality showed neutral to slightly alkaline pH ranging from 7.0 to 7.8. The concentration of total zinc showed an elevated freshet peak of 0.13 mg/L in May and an annual average concentration of 0.05 mg/L. The corresponding concentration of total suspended solids in May was high at 366 mg/L which may indicate that a portion of the total zinc may have been present as suspended material. The concentration of sulphate during 1998 ranged from 35 to 192 mg/L with the peak concentration occurring in December. The flow at location V15 was generally consistent in a range from 0.1 to 0.5 Lps. The water present at location V15 enters Grum Creek upstream of sampling location V2.

Groundwater wells P96-9A and P96-9B are nested in one drill hole in a bedrock valley at least 20 metres deep near surface monitoring location V15. The groundwater wells allow monitoring of groundwater seepage passing through the Grum Creek channel area which drains a portion of the Grum rock dump including the sulphide cell. Each piezometer was sampled twice during 1998 and water quality did not give a positive indication of the presence of acid generation products exiting the dump. The deeper well (P96-9B) which is screened over the interval from 16.5 to 18.0 metres below surface flows during summer and fall (i.e. piezometric head higher than the ground elevation). The range in concentrations of dissolved zinc and sulphate in the two piezometers during 1998 was from <0.01 to 0.07 mg/L and from 96 to 203 mg/L, respectively, with pH steady at 7.3.

3.5 GRUM CREEK (V2, V2A)

Location V2 is in Grum Creek upstream of entry into Vangorda Creek. The changes to the water management system implemented during 1995 and 1996 allow for the diversion of a substantial portion of Grum Creek water towards the Moose pond where the water is observed to seep into the ground and enter the groundwater regime. This diversion was put into place as part of the mitigation plan for reducing suspended sediment loadings entering Vangorda Creek via Grum Creek. Diverted Grum Creek water is sampled at location V2A prior to entry into the Moose pond at times when the diversion is in place. Location V2 is sampled in addition to sampling at location V2A even during times when the Moose pond diversion is in place. The diversion of part of Grum Creek into the Moose Pond was implemented in June 1996 and remained in place through 1998.

Location V2 was sampled on six occasions in 1998. The concentrations of total suspended solids and total zinc at location V2 in 1998 were improved over previous years as illustrated on Figures 3.5 and 3.6. No freshet spike in the concentration of total suspended solids was observed in 1998 and the peak concentration was within the discharge limit at only 12 mg/L. The flow at location V2 during 1998

ranged from 1.5 to 4 Lps. The concentration of total zinc during 1998 ranged from 0.01 to 0.10 mg/L with the peak concentration occurring in May. The elevated May peak in the concentration of total zinc corresponded to a freshet peak at upstream location V15.

FIGURE 3.5 GRUM CREEK (V2)

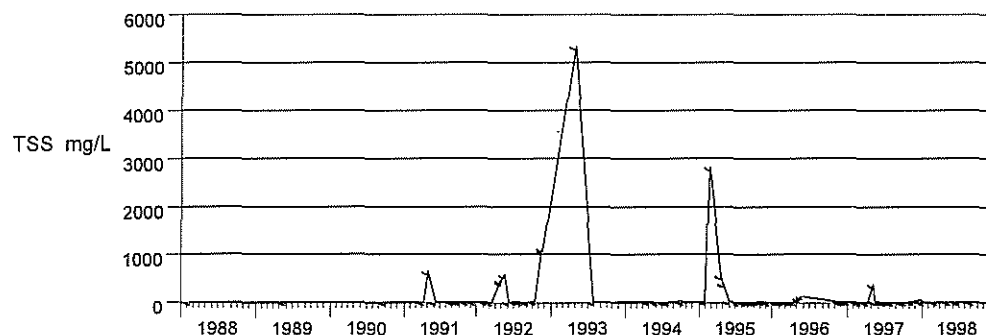
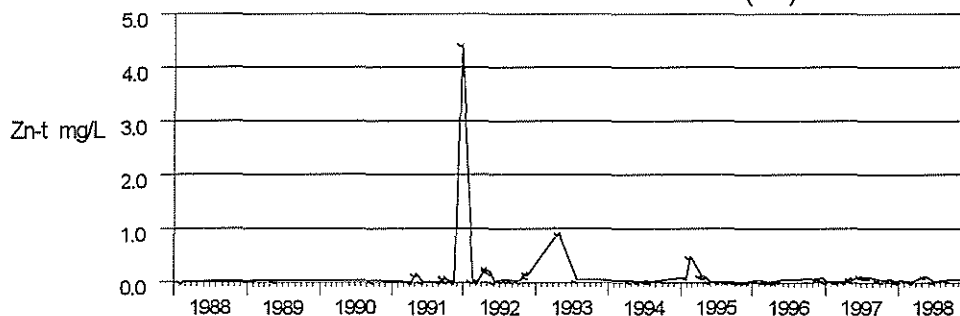


FIGURE 3.6 GRUM CREEK (V2)



Location V2A was sampled on two occasions in 1998. There was no flow present on other sampling occasions. Flow at location V2A was steady at 1 Lps in June and September. Water quality was good with metals at or near detection limits. The peak concentration of total zinc was 0.02 mg/L.

3.6 VANGORDA CREEK PLUNGE POOL (V19, V25BSP)

Location V19 is the Vangorda north west interceptor ditch which drains into Vangorda Creek at the plunge pool. A sump was built during April 1996 near the discharge end of the V19 ditch which allows the low flows of ditch water to seep into the ground, thereby eliminating a flow of potentially high suspended sediment into Vangorda Creek.

No flow was observed exiting the V19 ditch and no samples were collected during 1998.

Location V25BSP is not currently included in the licence but is necessary to monitor flow into Vangorda Creek from the Sheep Pad pond which was constructed during 1995 as part of the mitigative actions intended to minimize sediment loading into Vangorda Creek. The application for licence amendment currently under review includes the addition of location V25BSP to Schedule A of the licence.

Location V25BSP was sampled seven times during 1998 as flow allowed. There was no flow from mid-January through mid-April and no flow again from late-August through to year end. The flows observed

during 1998 were substantially less than the flows observed during 1996 and 1997 because, in previous recent years, all water discharged from the water treatment plant passed location V25BSP en route to Vangorda Creek while in 1998 there was no discharge from the water treatment plant. Flows at V25BSP in 1998 ranged from 0.01 to 13.2 Lps. These flows were calculated from staff gauge or head measurements applied to a standard formula for 90deg v-notch weirs. On several occasions early in 1998, visual estimates were also incorporated until repairs to one weir embankment were made.

One bioassay test was performed for location V25BSP in June as a check on toxicity associated with outflows from the Sheep Pad Pond. The test provided a result of non-lethal (no mortalities). The test was a 96 hour LC₅₀ test using rainbow trout and the results are listed in Appendix 2.

There were no exceedances of the maximum allowable discharge limits at location V25BSP during 1998 with the exceptions of two separate occasions where the concentrations of total suspended solids exceeded the limit of 15 mg/L. On January 6, the concentration of total suspended solids was 34 mg/L. On that occasion, the flow rate was extremely low and sampling conditions were likely the cause of the exceedance (i.e. chipping ice and frozen soil to expose a small leak around one weir abutment). On May 18, a freshet peak concentration of total suspended solids was 137 mg/L. This elevated concentration was estimated at a duration of approximately 1 week and a subsequent sample on May 31 contained only 8 mg/L total suspended solids.

On May 18, several other informal samples were collected to evaluate the freshet run off via location V25BSP. The concentration of total suspended solids at the inflow to the Sheep Pad pond was 1,306 mg/L which was much higher than that at location V25BSP. This indicates that the Sheep Pad pond was successfully mitigating the effects of freshet run off passing through the Grum interceptor ditch. The concentration of total suspended solids in Vangorda Creek immediately below the mixing zone with V25BSP inflows was only 5 mg/L which indicated that the V25BSP inflow had no negative effect on Vangorda Creek water.

Utilization of the Sheep Pad pond and the diversion of water through the Sheep Pad ponds has resulted in direct improvements in suspended sediment and metal loadings entering Vangorda Creek via Grum Creek. For example, prior to construction of the Sheep Pad pond in late 1995, the very high 1998 freshet concentration of total suspended solids described above (1,306 mg/L) at the inflow to the Sheep Pad pond would likely have entered Vangorda Creek via Grum Creek. The elevated 1998 freshet concentration of total suspended solids at location V25BSP (137 mg/L) represents an improvement over water quality prior to construction of the Sheep Pad pond and is lower than the freshet peak observed in 1997. Continued improvements at location V25BSP are expected as a result of on-going upgrading to the ditch, natural stabilization due to grass growth and natural washing/removal of available fine material.

The concentrations of total zinc at location V25BSP in 1998 were generally slightly elevated and ranged from 0.08 to 0.39 mg/L. The sources of the total zinc are not clear. The highest concentrations occurred in January during extremely low flows and the comments above regarding winter sampling conditions affecting total suspended sediments may also apply here.

3.7 AEX CREEK (V17A, V6A)

Location V17A is not currently included in the water licence but is proposed as a replacement for location V17 in the licence amendment application currently under review. Location V17A is a small stream which contains natural run off from the slopes north of the Grum pit as well as surface run off from the north side of the Ore Transfer Pad. This stream then passes into AEX Creek which is sampled further downstream at location V6A.

Location V17A was sampled on three occasions in 1998. There was no flow during the winter seasons from January through March and from November through December. There was no significant freshet

peak in the concentrations of some metals observed in 1998 as there was in 1997. In 1998, the highest reported concentration of total zinc occurred in May at 0.05 mg/L and the maximum concentration of total suspended solids was 9 mg/L also in May.

Location V6A is AEX Creek immediately prior to entry into the west fork of Vangorda Creek and was sampled on six occasions in 1998. Water quality remained generally good through 1998. The concentration of total zinc was unusually elevated at 0.34 mg/L, however, on one occasion in January 1998. Although the cause of this event is unknown, the corresponding concentration of total suspended solids was also high at 66 mg/L indicating that the source of the zinc may have been suspended material. The freshet concentration of total zinc in May was 0.08 mg/L which was slightly less than the freshet peak observed in 1997.

4. RECEIVING AND BACKGROUND WATER QUALITY

4.1 SHRIMP CREEK (V4)

Location V4 is Shrimp Creek upstream of the confluence with the main fork of Vangorda Creek. This location provides reference information regarding background water quality.

There were four samples collected at location V4 during 1998. The water at location V4 continued to be harder than the other background water quality reference location in Vangorda Creek (V1) as was observed in 1997 with higher hardness, calcium and magnesium. The increased hardness may be due to the presence of calcareous phyllites in the drainage area of Shrimp Creek which are not present in the drainage area of Vangorda Creek above location V1. Metal concentrations in Shrimp Creek were generally at or near detection limits with the exception of total zinc which was measured as high as 0.08 mg/L in May.

4.2 UPPER VANGORDA CREEK (V1, V27)

"Upper" Vangorda Creek is the primary receiving water for mine site discharges and is sampled upstream of mine activities at V1, and locally downstream of mine activities at V27 above the confluence with Shrimp Creek. There is no known fish habitat in "upper" Vangorda Creek due to natural impasses near the town of Faro.

Location V1 is the main fork of Vangorda Creek immediately upstream of mine activities. This location provides information regarding background water quality upstream of the mine site.

There were four samples collected at location V1 during 1998. During 1998, pH ranged from 7.2 to 7.9, sulphate concentrations ranged from 10 to 24 mg/L, and hardness ranged from 237 to 325 mg/L (325 mg/L is unusually high for this location). The concentrations of most total metals were at or near detection limits with the exceptions of total iron which ranged from <0.01 to 0.61 mg/L and total zinc which was unusually high in December at 0.05 mg/L. The concentration of total suspended solids was low throughout the year at less than 2 mg/L.

Location V27 is the main fork of Vangorda Creek upstream of the confluence with Shrimp Creek and provides information regarding the impact on Vangorda Creek from mining activities on the Vangorda Plateau. All surface water from the Grum rock dump, the Grum interceptor ditch/Sheep Pad Pond, and the Vangorda north east interceptor ditch report to location V27 via Grum Creek or the Vangorda Creek plunge pool.

There were three samples collected at location V27 during 1998. The concentration of total zinc was measured as high as 0.09 mg/L in May. The highest concentration of sulphate in 1998 was 45 mg/L in May and ammonia was measured <0.05 mg/L on all samples. The cause of the measurable zinc in the water at location V27 is unknown, particularly given that there was no water discharged from the water treatment plant during 1998 and effluent flows from the minesite were much lower than in recent years.

4.3 LOWER VANGORDA CREEK (V5, VGMAIN, V8)

"Lower" Vangorda Creek is near the town of Faro and the juvenile fish rearing habitat in the first 1 to 2 km above the mouth of the creek. The west fork just upstream of the confluence with the main fork and the lowest stretch of creek below the confluence of the two tributary forks are routinely sampled per licence requirements. The main fork just upstream of the confluence with the west fork is informally sampled as added information regarding the potential contributions of contaminants to the area of juvenile fish habitat.

Location V5 is the west fork of Vangorda Creek upstream of the confluence with the main fork. Location V5 receives drainage from AEX Creek and, thereby, potential influences from surface drainage from the north portion of the Ore Transfer Pad. Both AEX and West Fork Vangorda Creeks receive drainage from the Vangorda ore haul road and the mine access road. Road maintenance activities such as re-surfacing or application of dust suppression products or spills could potentially affect water quality at V5. There is a small portion of the Grum calcareous phyllite rock dump which drains into the west fork of Vangorda Creek between AEX Creek and location V5. This portion of the Grum rock dump does not include any part of the sulphide cell.

There were eleven samples collected at location V5 during 1998. Sampling was increased informally from the required quarterly schedule to a monthly schedule in order to ensure that adequate information was collected concerning water quality affecting the fish habitat area. Water quality at location V5 did not show a negative influence from mine activities. The concentration of total suspended solids was less than 16 mg/L through the year with the maximum recorded in May. The concentrations of total iron and total aluminum were also elevated in May in concert with the maximum total suspended solids concentration indicating that the source of these metals may have been clayey sediment in suspension. A very high spike in the concentration of total zinc of 1.31 mg/L was recorded in October. This concentration is considered anomalous and not representative of any actual event since it is supported by neither other water quality parameters at location V5 nor by zinc concentrations at other related locations such as downstream location V8. The next highest concentration of total zinc in 1998 was 0.28 mg/L in April and the average concentration of total zinc in 1998 excluding the anomalous spike was 0.05 mg/L.

The concentrations of sulphate and hardness at location V5 continued to exhibit a general seasonal trend during 1998 in which these concentrations were greater during the winter season when surface run off is at a minimum. These observations are in agreement with previous hypotheses that groundwater seepage from the Red River and Earn Group rocks is responsible for the observed trends in sulphate in the West Fork and lower section of Vangorda Creek and that seepage from Vangorda Formation rocks is similarly responsible for observed seasonal trends in hardness in the West Fork and lower Vangorda Creek. The ranges in concentrations of sulphate and hardness at location V5 in 1998 were from 24 to 461 mg/L and from 176 to 971 mg/L, respectively.

Location VGMAIN is an informal sampling location located in the main fork of Vangorda Creek immediately upstream of the confluence with the west fork. Water quality at this location provides important information regarding the relative impacts of the main and west forks on the fish rearing habitat in lower Vangorda Creek. Although licence location V27 is also in the main fork, location V27 is several kilometers upstream of the confluence with the west fork and it is difficult to utilize water quality data from location V27 in an analysis of lower Vangorda Creek because of the potential for numerous and unquantified impacts on the main fork between location V27 and the confluence with the west fork.

A total of nine samples were collected at location VGMAIN in 1998. The concentration of total suspended solids at location VGMAIN followed the established trend for the area with generally low concentrations and a brief spring spike (17 mg/L on May 19) although the spring peak observed in 1998 was significantly lower than that observed in 1997. The concentration of ammonia was very low with all samples reporting <0.05 mg/L. The peak and average concentrations of total zinc in 1998 were 0.32 mg/L and 0.07 mg/L, respectively. The peak concentration of total zinc occurred in April and was higher than spring zinc concentrations recorded in 1997.

The concentrations of sulphate and hardness at location VGMAIN followed a seasonal trend in 1998 as observed for location V5 with higher concentrations observed in the winter season. The ranges in concentrations of sulphate and hardness in 1998 were from 21 to 149 mg/L and from 87 to 371 mg/L, respectively.

Location V8 is in the Vangorda Creek fish rearing area near the confluence with the Pelly River. There were eleven samples collected at location V8 during 1998.

The concentration of total suspended solids at location V8 was improved in 1998 over previous years. The highest concentration observed was 29 mg/L in September and was thought to be related to local activities and not to any upstream event. The highest concentration observed during spring 1998 was only 13mg/L in May.

The highest concentration of total zinc observed at location V8 during 1998 was 0.26 mg/L in April. This spring peak was greater than that observed in 1997. The 1998 spring peak coincided with similar concentrations at both upstream locations V5 (0.28 mg/L) and VGMAIN (0.32 mg/L). The next highest concentration of total zinc observed at location V8 in 1998 was 0.07 mg/L in May and the average concentration of total zinc in 1998 was 0.05 mg/L. The direct cause of the elevated zinc concentrations is unknown but may be related to the remobilization of zinc from creek bed sediments which were deposited in previous years.

Concentrations of total lead at location V8 were less than detection limit (<0.02 mg/L) throughout 1998 with the single exception of a concentration of 0.04 mg/L reported on May 19 which was less than a spring peak of 0.14 mg/L recorded in May 1997. Concentrations of ammonia were all less than detection limit (<0.05 mg/L) in 1998. The concentration of total iron was as high as 0.75 mg/L in May.

The trend in the concentration of sulphate at location V8 closely followed that at location V5 during 1998. Operation of the water treatment plant in previous years has been suspected of altering the trend in sulphate at location V8 away from the more "natural" trend observed in 1998. The hardness observed at location V8 in 1998 closely followed the trend described for locations V5 and VGMAIN with greater hardness recorded in the winter season when surface flows were at a minimum.

The concentrations of total suspended solids, total zinc, total sulphate and hardness which were measured for locations V5, VGMAIN and V8 during 1997 and 1998 are illustrated on Figures 4.1 through 4.4, respectively.

FIGURE 4.1 LOWER VANGORDA CREEK (TSS)

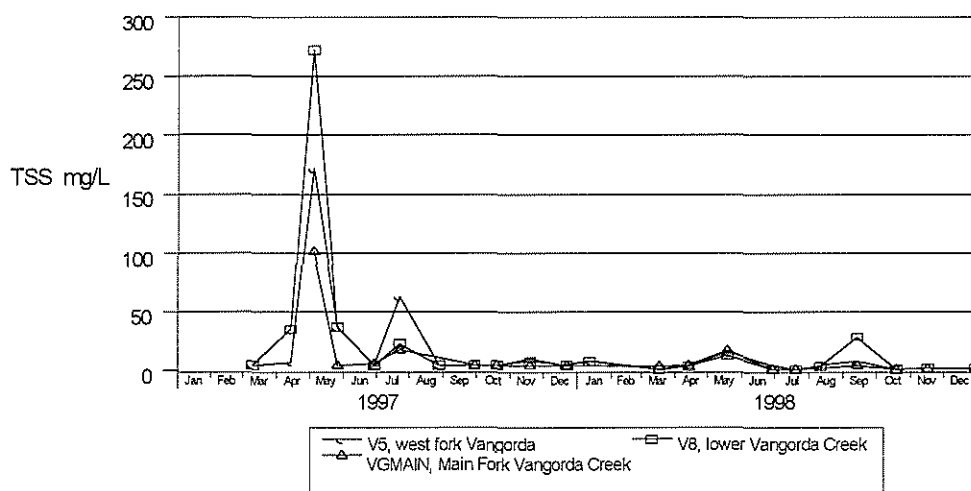


FIGURE 4.2 LOWER VANGORDA CREEK (ZINC)

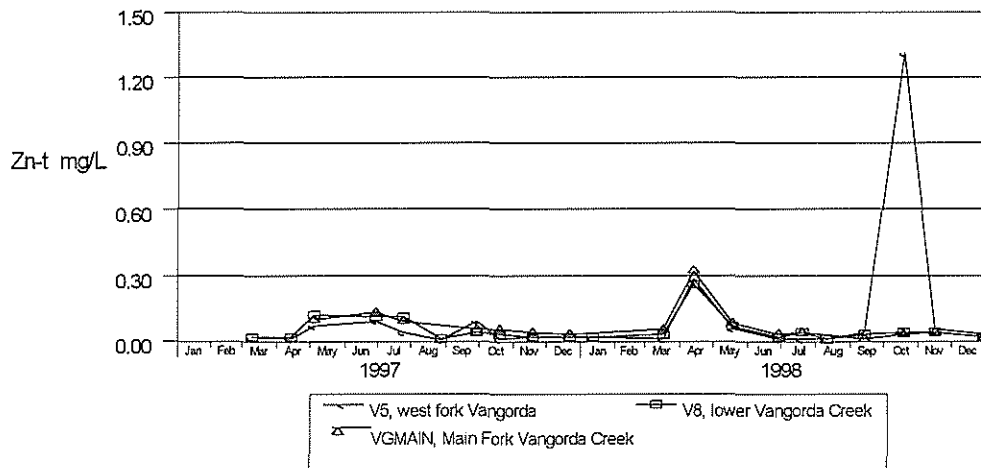


FIGURE 4.3 LOWER VANGORDA CREEK (SO4)

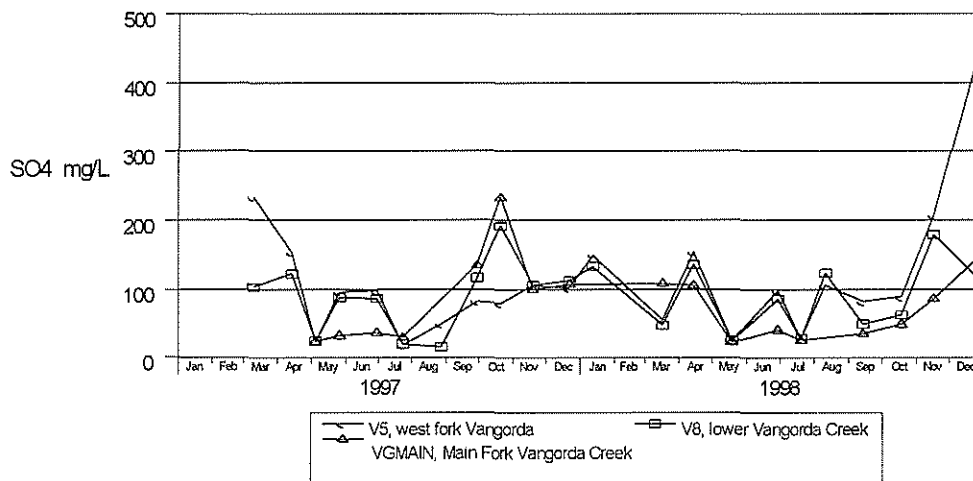
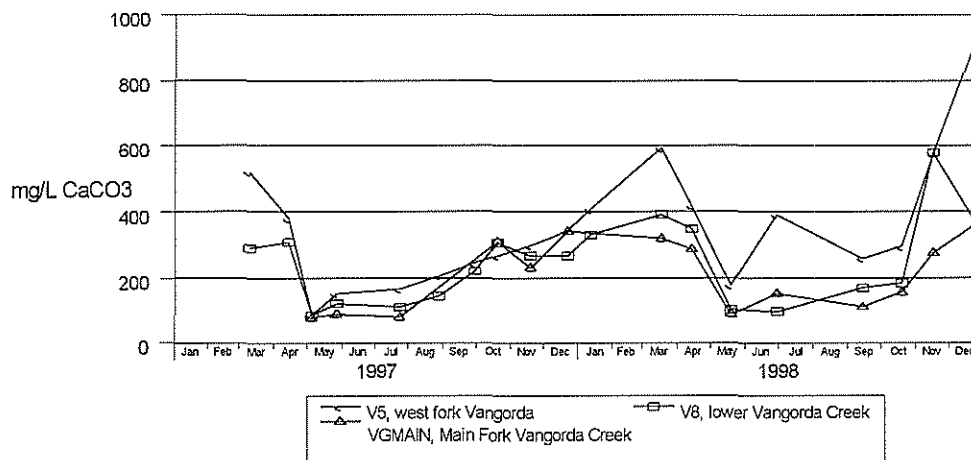


FIGURE 4.4 LOWER VANGORDA CREEK (HARDNESS)



4.4 LONG TERM TRENDS IN LOWER VANGORDA CREEK

The longer term trends in water quality in lower Vangorda Creek from 1988 to 1996 indicate that mining activities on the Vangorda Plateau have had an influence on concentrations of total suspended solids, total zinc, total lead and ammonia in lower Vangorda Creek. It is also evident that water quality in the West Fork (V5) can have a significant effect on water quality in lower Vangorda Creek particularly for total suspended solids and sulphate and that the presence of these parameters in the West Fork is unrelated to current activities at the mine site. There are also likely sources of suspended sediments entering Vangorda Creek in the main fork below the minesite and in lower Vangorda Creek below the confluence of the main and west forks.

During the period 1988 to 1990 (3 years), there was a relatively small amount of work done in overburden stripping for the Grum Open Pit. Although relatively few water samples were collected during this period, the water quality at location V8 during this period could be taken as representative of conditions largely unaffected by mine operations. This is evident through relatively low concentrations of total suspended solids, total zinc, ammonia, total lead and arsenic although the concentration of total zinc was recorded at or just greater than the recommended guideline for the protection of freshwater aquatic life (CCREM) on two occasions. The average concentration of total suspended solids during this period was 12 mg/L with a peak value of 30 mg/L late in 1990. Similarly, the average and peak concentrations of total zinc were 0.024 mg/L and 0.036 mg/L, respectively.

During 1991 and 1992, a substantial overburden stripping program was carried out on the Vangorda Plateau, mining was performed in the Vangorda Open Pit and the Vangorda ore haul road was constructed. The effect of this mining activity is reflected in the water quality in lower Vangorda Creek. The concentrations of total suspended solids, total zinc, total lead and ammonia all show an increase in average and peak values during this period. The average concentration of total suspended solids during this period was 62 mg/L with a peak value of 590 mg/L in spring 1991. Similarly, the average and peak concentrations of total zinc were 0.057 mg/L and 0.36 mg/L, respectively.

During 1993 and 1994, no mining operations were performed on the Vangorda Plateau. Although fewer water samples were collected during this period than during the previous operating period, reduced levels of total suspended solids and total zinc were observed in lower Vangorda Creek. The reduced levels were generally greater than those observed during the period preceding mine activities (1988 to 1990). The average concentration of total suspended solids during 1993 and 1994 was 40 mg/L with a peak value of 112 mg/L in spring 1994. Similarly, the average and peak concentrations of total zinc were 0.034 mg/L and 0.11 mg/L, respectively.

During 1995, 1996 and 1997, mining activities on the Vangorda Plateau were resumed including operation of and discharge of treated effluent from the water treatment plant. Even in light of the resumption of mine operations, water quality in lower Vangorda Creek during this period did not show a return to the quality observed during the previous period of mine operations on the Vangorda Plateau (1991 and 1992). The concentrations of total suspended solids, total zinc, total lead, ammonia and arsenic observed from 1995 through 1997 remained similar to those observed during the shut down period of 1993 and 1994. During this period, the average concentration of total suspended solids was 29 mg/L with a peak value of 271 mg/L. Similarly, the average and peak concentrations of total zinc were 0.038 mg/L and 0.12 mg/L, respectively.

In 1998, mining activities were again suspended including suspension of operation of and discharge of treated effluent from the water treatment plant. The water quality observed in lower Vangorda Creek during 1998 was generally improved slightly over that observed during the preceding period of mine operation (1995 through 1997) although the improvement did not appear to be substantial. Additional timeline information is required before further evaluation of any emerging trends can be confidently made.

Long term water quality for selected parameters is illustrated on Figures 4.5 through 4.12.

FIGURE 4.5 LONG TERM TRENDS VANG CK (TSS)

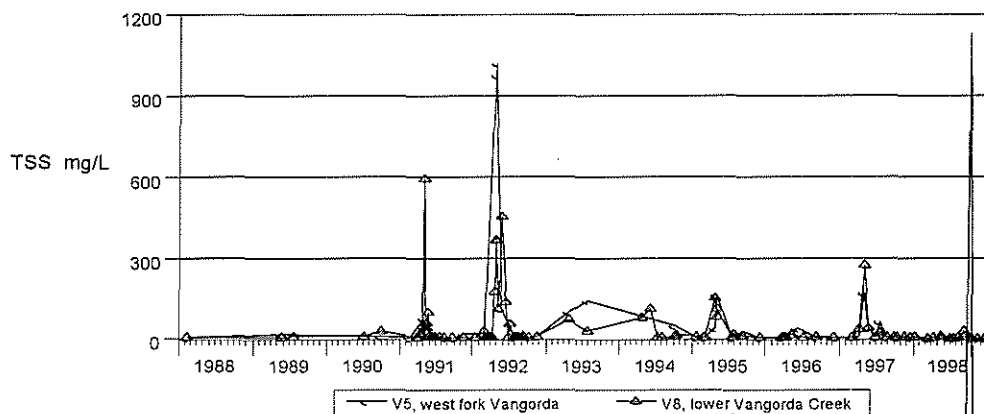


FIGURE 4.6 LONG TERM TRENDS VANG CK (ZINC)

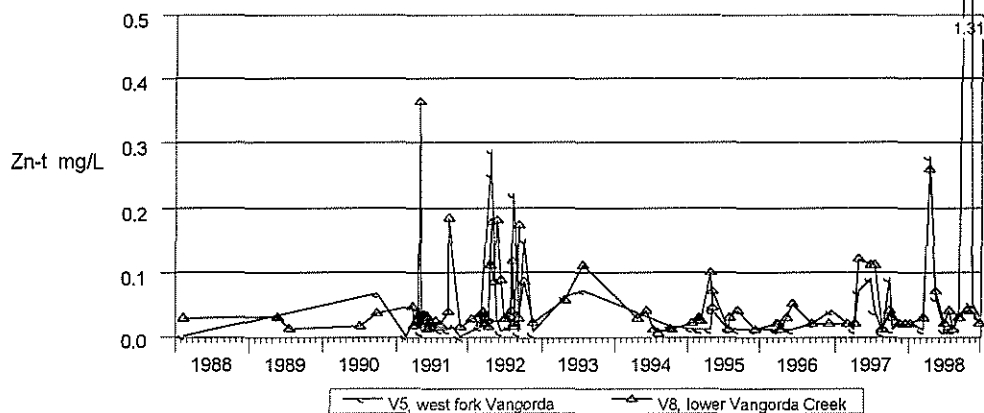


FIGURE 4.7 LONG TERM TRENDS VANG CK (LEAD)

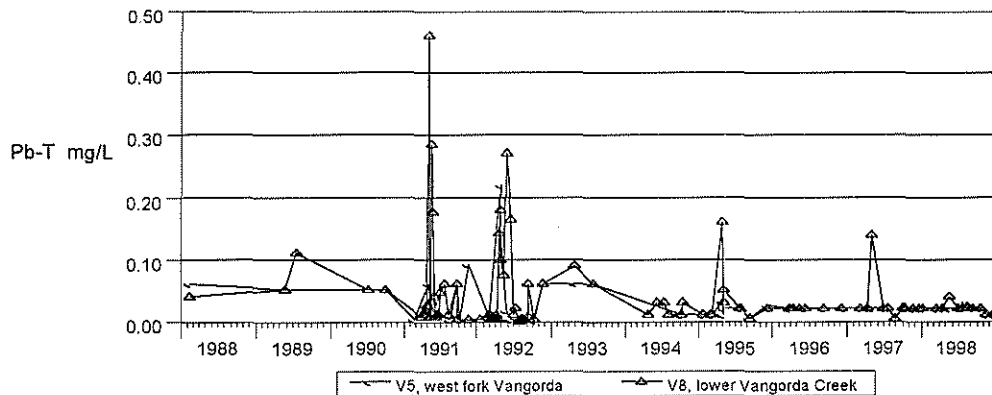


FIGURE 4.8 LONG TERM TRENDS VANG CK (NH3)

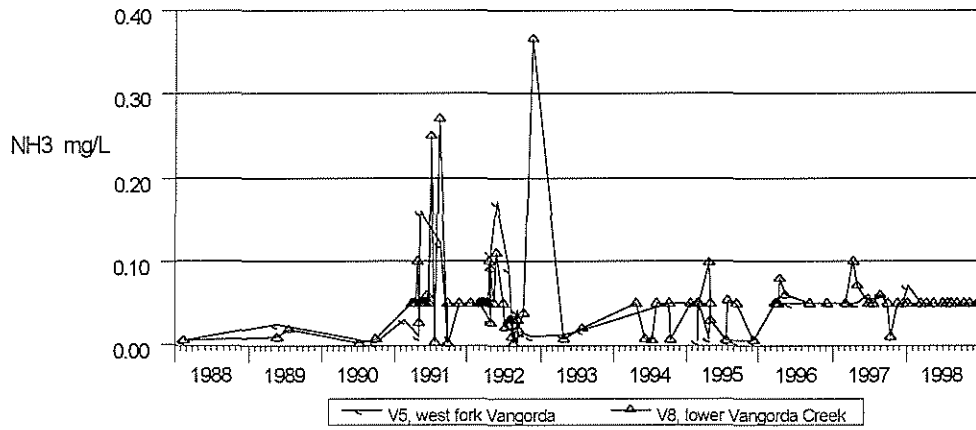


FIGURE 4.9 LONG TERM TRENDS VANG CK (ARSENIC)

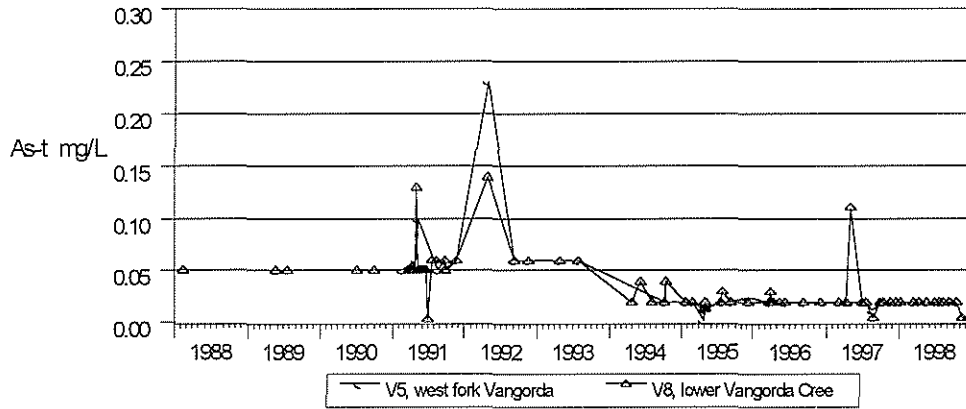


FIGURE 4.10 LONG TERM TRENDS VANG CK (SO4)

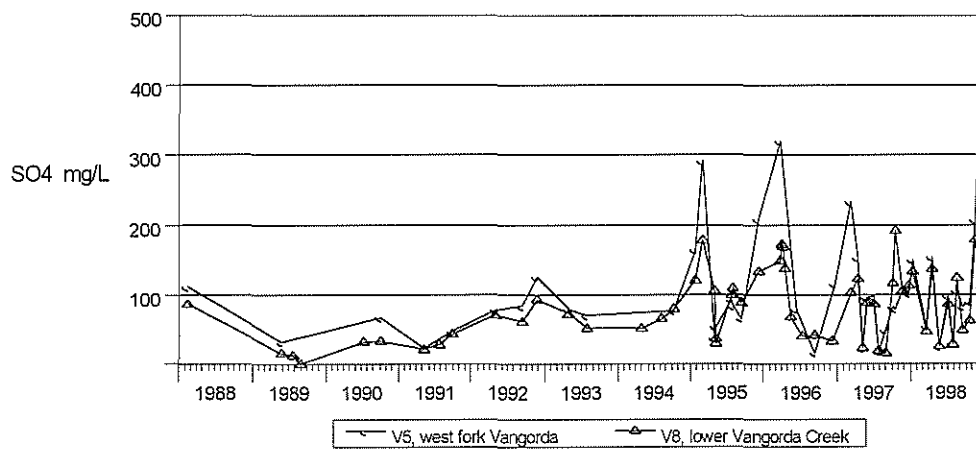


FIGURE 4.11 LONG TERM TRENDS VANG CK (HARDNESS)

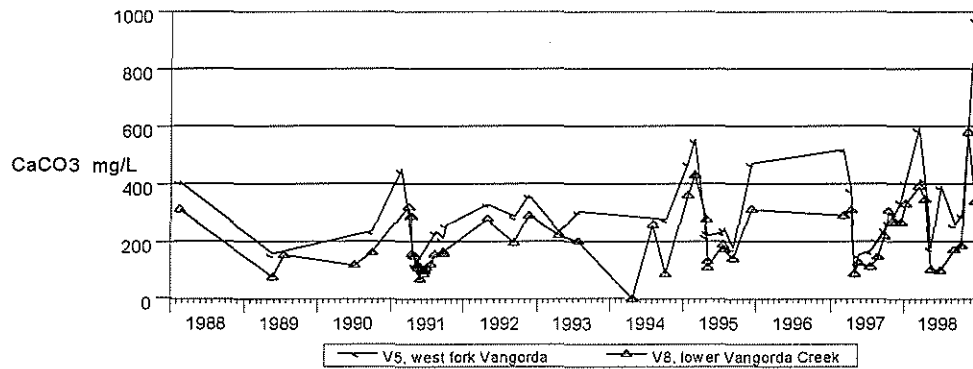
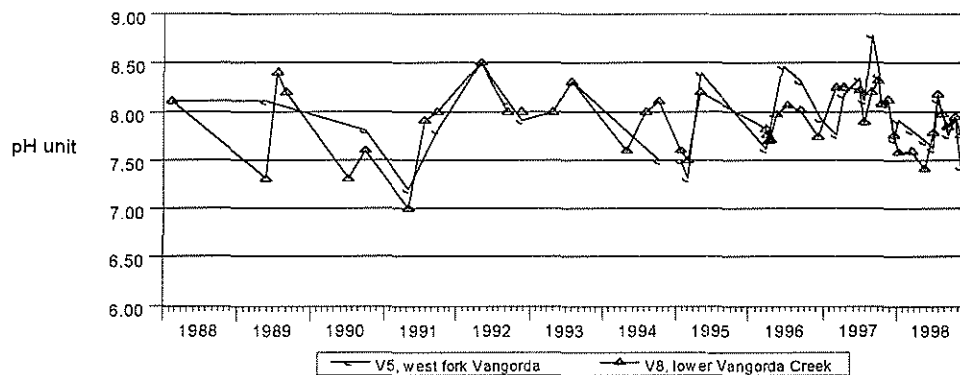


FIGURE 4.12 LONG TERM TRENDS VANG CK (PH)



Measured flow volumes in the West Fork (V5) and lower Vangorda Creek (V8) are illustrated on Figure 4.13. A total of 19 corresponding flow measurements at V5 and V8 spanning 1991 to 1998 are listed in Appendix 2 and indicate that, on average, the West Fork contributes 34% of flow to lower Vangorda Creek with a range from 21% to 49%.

FIGURE 4.13 LONG TERM TRENDS VANG CK (FLOW)

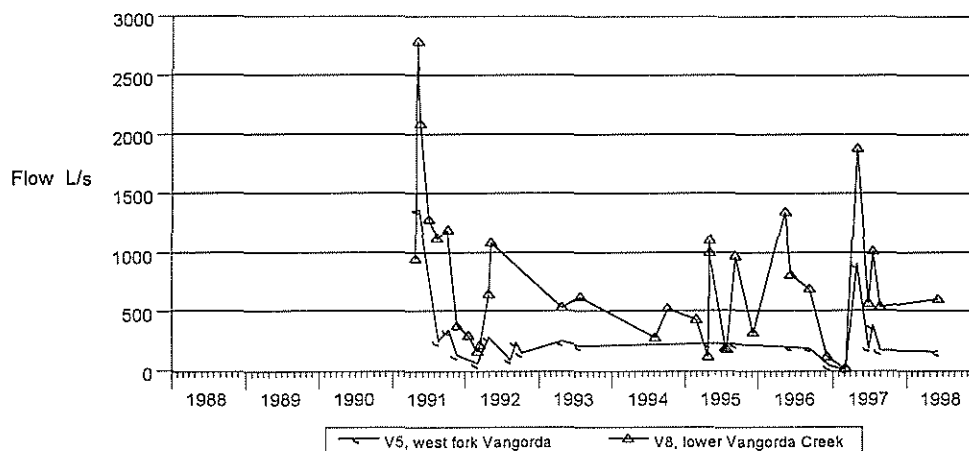


TABLE 4.1
COMPARISON OF MEASURED FLOWS AT V5 AND V8 TO END OF 1998

STATION: V5		STATION: V8		% V5/V8
Date	FLOW L/s	Date	FLOW L/s	
07/05/91	1358	07/05/91	2778	49%
22/08/91	249	15/08/91	1116	22%
11/10/91	334	04/10/91	1182	28%
26/11/91	131	25/11/91	372	35%
28/02/92	51	28/02/92	153	33%
28/04/92	280	28/04/92	634	44%
26/04/93	243	26/04/93	533	46%
02/08/93	207	02/08/93	620	33%
09/05/95	230	09/05/95	1096	21%
12/09/95	224	12/09/95	960	23%
11/06/96	195.3	11/06/96	801	24%
11/09/96	191.6	11/09/96	687	28%
19/12/96	35	05/12/96	110	32%
10/03/97	7	10/03/97	15	47%
05/05/97	892	05/05/97	1873	48%
30/06/97	185	30/06/97	566	33%
24/07/97	379	24/07/97	1007	38%
28/08/97	162	28/08/97	541	30%
10/06/98	152	10/06/98	594	26%
				AVG 34%
				MAX 49%
				MIN 21%
				COUNT 19
				MEDIAN 33%

5. BENTHIC, SEDIMENT, AND WILDLIFE MONITORING

5.1 BENTHIC AND SEDIMENT MONITORING

Water licence IN89-002 requires monitoring of benthic organisms and metal levels in sediments in Vangorda Creek every two years. Since this monitoring was performed in 1997 as reported in the 1997 Annual Environmental Report, neither program was required in 1998 and neither program was performed in 1998.

Both the sediment and benthic monitoring programs are scheduled to be performed in 1999.

5.2 WILDLIFE MONITORING

The Fannin Sheep were observed at the minesite during their seasonal migrations to and from the wintering grounds on Sheep Mountain. The sheep were primarily observed in the vicinity of the Sheep Pad pond. Sheep tracks were observed on the Grum Creek road below the Grum rock dump which agrees with observations in 1997 of the sheep traveling down that road toward their winter range.

Bears, moose and foxes were sighted on and near the minesite on numerous occasions during 1998.

6. GEOTECHNICAL MONITORING

The annual physical monitoring program required under Part D Section 6 of the licence was performed in July 1998 by Mr. Peter Healey of SRK (Steffen, Robertson and Kirsten Inc.). The SRK report is appended as Appendix 3 and the following summary is provided.

The inspection looked at the geotechnical performance and stability of the following structures: Vangorda rock dump and seepage collection system, Little Creek Dam, Vangorda Creek diversion, Clarification Pond, Sheep Pad ponds and Grum rock dumps.

The conclusions and recommendations resulting from the inspection are summarized as follows:

- maintenance work required around Vangorda dump drain #6 and seepage collection channel,
- maintenance work on Little Creek Dam,
- continue monitoring of piezometers and thermistors,
- monitor for tension cracking and seeps related to dams and dykes,
- repair various rip rap structures at culvert inlets and Vangorda Creek diversion,
- verify flow capacity of plunge pool area allowing for water diverted via Sheep Pad ponds,
- maintenance work and monitoring on Clarification and Sheep Pad pond dykes.

The SRK study included a review of all available data collected from monitoring of piezometers and thermistors related to the Vangorda rock dump and Little Creek Dam. No significant trends were identified and no concerns were noted.

7. WATER TREATMENT PLANT PERFORMANCE

The Water Treatment Plant was not operated during 1998. The only period of active mining during 1998 was during January and water flows into the open pits during that time were not sufficient to require operation of the plant. Therefore, no performance report on the operation of the plant is required for 1998.

The water treatment plant was shut down in an orderly manner at the cessation of mining activities in January 1998 such that all lines and tanks were drained of water. Electrical power to the plant was cut off at the time of shut down and remained disconnected through the remainder of 1998.

8. TECHNICAL ADVISORY COMMITTEE

One TAC (Technical Advisory Committee) meeting was held in 1998 in June. The meeting was held in Faro and involved tours of the Faro and Vangorda Plateau minesites. The meeting was chaired by a representative of Deloitte & Touche Inc. as receivers for Anvil Range Mining Corporation and was attended by representatives of:

Access Mining Consultants Ltd.

Deloitte & Touche Inc. as receivers for Anvil Range Mining Corporation

DIAND - Environment Directorate

DIAND - Mineral Resources

DIAND - Mining Land Use

DIAND - Water Resources

Environment Canada

Ross River Dena

Selkirk First Nation

Town of Faro

Yukon Conservation Society

YTG - Economic Development

YTG - Renewable Resources

The topics discussed at the meeting were primarily concerned with current environmental issues and on-going environmental management of the minesites during the interim receivership.

A list of the attendees, agenda and minutes for the meeting are included in Appendix 4.

9. MAINTENANCE AND MODIFICATIONS

9.1 LITTLE CREEK DAM EMERGENCY OVERFLOW

An emergency overflow system for Little Creek Dam was designed and constructed during 1998. The primary benefit of constructing an emergency overflow system is increased protection for the embankment in the event of a major flood event. The system was designed by SRK in consultation with DIAND and Deloitte and Touche and was constructed by Deloitte and Touche. The system comprises a 900mm diameter corrugated metal pipe buried in the embankment near the south abutment with rock lined downstream plunge pool and outlet ditch.

The full consultant report regarding design and construction of the system as prepared by SRK is appended here as Appendix 5.

9.2 DIAND RECLAMATION WORK ON THE VANGORDA ROCK DUMP

The Ross River Dena Development Corporation performed reclamation work on the Vangorda rock dump on behalf of DIAND Water Resources in September and October 1998.

No details of this work are provided here.

9.3 FLOW MONITORING SYSTEMS

The weir installed at location V25BSP which is the outflow ditch from the Sheep Pad Pond above the Vangorda Creek plunge pool was replaced in spring 1998. This was necessary because one of the side embankments had washed out resulting in significant leakage of water around the v-notch weir. The repair was completed in June 1998.

10. LICENCE ISSUES

10.1 AMENDMENTS

An application for amendment to Water Licence IN89-002 was outstanding at year end. The application was filed in 1995 by Anvil Range Mining Corporation and an update to the application was filed in 1996. The proposed amendments are primarily "housekeeping" issues.

APPENDIX 1

**1998 COMPLETE WATER QUALITY LISTING
WITH STATISTICAL SUMMARIES**

VANGORDA PLATEAU SITE WATER QUALITY LISTING - 1998

STATION: V1, Vangorda Creek, upstrm of mine & Blind Cr. Rd

	PH-F	FLOW	SO4-T	TSS	NH3-N	HARD-T (CaCO3)	ACIDITY (CaCO3)	ALK-T
Date	pH unit	L/s	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
18/05/98	7.6		24	1	<0.05	23		
30/05/98		1426						peak flow
09/06/98		580						
30/06/98	7.6		17	<1	<0.05	325		
14/09/98	7.88		10	2	<0.05	29		
31/12/98	7.16		13	1	<0.05	58		ice layer

JAN 1998 - DEC 1998

Mean	7.56	1003	16	1	0.05	109		
Std. Devia	0.3	598	6	0	0	145		
Minimum	7.16	580	10	1	0.05	23		
Maximum	7.88	1426	24	2	0.05	325		
Median	7.6	1003	15	1	0.05	44		
Num. Valu	4	2	4	4	4	4		

STATION: V2, Grum Creek, upstr. of Vangorda Ck

	PH-F	FLOW	SO4-T	TSS	NH3-N	HARD-T (CaCO3)	ACIDITY (CaCO3)	ALK-T
Date	pH unit	L/s	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
12/01/98	7.8	1.5	82	9	0.12			
17/03/98	7.45	1.5	28	9	<0.05			
18/05/98	7.7	4	234	1	<0.05			
29/06/98	7.1	2	115	1	<0.05			
14/09/98		2	125	2	<0.05			
31/12/98	7.22		154	12	0.05			dispersed flow

JAN 1998 - DEC 1998

Mean	7.45	2.2	123	6	0.06			
Std. Devia	0.3	1	69	5	0.03			
Minimum	7.1	1.5	28	1	0.05			
Maximum	7.8	4	234	12	0.12			
Median	7.45	2	120	6	0.05			
Num. Valu	5	5	6	6	6			

VANGORDA PLATEAU SITE WATER QUALITY LISTING - 1998

STATION: V2A, Grum Creek Diversion to Moose Pond

	PH-F	FLOW	SO4-T	TSS	NH3-N	HARD-T (CaCO3)	ACIDITY (CaCO3)	ALK-T
Date	pH unit	L/s	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
18/05/98		0						no flow
29/06/98	7.09	1	124	<1	<0.05			Moose Pond m.t.
14/09/98		1	116	4	<0.05			Moose Pond m.t.

JAN 1998 - DEC 1998

Mean	7.09	1	120	2	0.05			
Std. Devia	0	0	6	2	0			
Minimum	7.09	1	116	1	0.05			
Maximum	7.09	1	124	4	0.05			
Median	7.09	1	120	2	0.05			
Num. Valu	1	2	2	2	2			

STATION: V4, Shrimp Creek, upstr. of Vangorda Creek

	PH-F	FLOW	SO4-T	TSS	NH3-N	HARD-T (CaCO3)	ACIDITY (CaCO3)	ALK-T
Date	pH unit	L/s	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
29/05/98	7.02		17	2	<0.05			
29/06/98	7.91		14	1	<0.05	355		
14/09/98			68	3	<0.05	370		

JAN 1998 - DEC 1998

Mean	7.46		33	2	0.05	362		
Std. Devia	0.63		30	1	0	11		
Minimum	7.02		14	1	0.05	355		
Maximum	7.91		68	3	0.05	370		
Median	7.46		17	2	0.05	362		
Num. Valu	2		3	3	3	2		

VANGORDA PLATEAU SITE WATER QUALITY LISTING - 1998

STATION: V5, west fork Vangorda Creek

	PH-F	FLOW	SO4-T	TSS	NH3-N	HARD-T (CaCO3)	ACIDITY (CaCO3)	ALK-T
Date	pH unit	L/s	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
13/01/98	7.91		149	9	0.07	408		d/s culvert
17/03/98	7.8		53	<1	<0.05	591		d/s culvert
14/04/98			153	4	<0.05	416		
19/05/98	7.7		24	16	<0.05	176		
10/06/98		152						
30/06/98	7.62		98	5	<0.05	391		
21/07/98	8.12		27	<1	<0.05			
11/08/98	8.01		105	5	<0.05			
15/09/98	7.76		81	8	<0.05	256		
19/10/98	7.92		88	1	<0.05	293		
17/11/98	7.42		206	2	<0.05	574		
31/12/98	7.12		461	<1	<0.05	971		ice layer

JAN 1998 - DEC 1998

Mean	7.74	152	131	5	0.05	453		
Std. Devia	0.3	0	122	5	0.01	237		
Minimum	7.12	152	24	1	0.05	176		
Maximum	8.12	152	461	16	0.07	971		
Median	7.78	152	98	4	0.05	408		
Num. Valu	10	1	11	11	11	9		

STATION: V6A, AEX Creek

	PH-F	FLOW	SO4-T	TSS	NH3-N	HARD-T (CaCO3)	ACIDITY (CaCO3)	ALK-T
Date	pH unit	L/s	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
13/01/98	7.53		20	66	<0.05			
17/03/98			7	<1	<0.05			
19/05/98	7.4		9	10	<0.05			
30/06/98	7.52		86	3	<0.05			
15/09/98	7.98		12	4	<0.05			
31/12/98	6.39		26	5	<0.05			

JAN 1998 - DEC 1998

Mean	7.36		27	15	0.05			
Std. Devia	0.59		30	25	0			
Minimum	6.39		7	1	0.05			
Maximum	7.98		86	66	0.05			
Median	7.52		16	4	0.05			
Num. Valu	5		6	6	6			

VANGORDA PLATEAU SITE WATER QUALITY LISTING - 1998

STATION: VGMAIN, Main Fork Vangorda Creek

	PH-F	FLOW	SO4-T	TSS	NH3-N	HARD-T (CaCO3)	ACIDITY (CaCO3)	ALK-T
Date	pH unit	L/s	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
17/03/98	7.6		107	4	<0.05	318		
14/04/98			105	5	<0.05	285		
19/05/98	7.5		21	17	<0.05	87		
30/06/98	7.82		40	<1	<0.05	152		
21/07/98	8.13		24	1	<0.05			
15/09/98	7.81		34	5	<0.05	109		
19/10/98	7.91		48	1	<0.05	155		
17/11/98	7.75		86	2	<0.05	275		
31/12/98	7.21		149	<1	<0.05	371		

JAN 1998 - DEC 1998

Mean	7.72		68	4	0.05	219		
Std. Devia	0.28		45	5	0	106		
Minimum	7.21		21	1	0.05	87		
Maximum	8.13		149	17	0.05	371		
Median	7.78		48	2	0.05	215		
Num. Valu	8		9	9	9	8		

STATION: V8, lower Vangorda Creek

	PH-F	FLOW	SO4-T	TSS	NH3-N	HARD-T (CaCO3)	ACIDITY (CaCO3)	ALK-T
Date	pH unit	L/s	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
13/01/98	7.58		132	8	<0.05	328.1499		vehicle bridge
17/03/98	7.59		46	<1	<0.05	389		ice cleared
14/04/98			136	4	<0.05	345		vehicle bridge
19/05/98	7.4		24	13	<0.05	102		vehicle bridge
10/06/98		594						vehicle bridge
30/06/98	7.78		86	1	<0.05	97		vehicle bridge
21/07/98	8.18		27	<1	<0.05			vehicle bridge
11/08/98	7.98		123	4	<0.05			vehicle bridge
15/09/98	7.84		48	29	<0.05	169		turbid/dozer work?
19/10/98	7.95		62	<1	<0.05	183		vehicle bridge
17/11/98	7.75		179	2	<0.05	577		ice layer/veh. bridge
31/12/98	7.08		111	2	<0.05	335		walking bridge

JAN 1998 - DEC 1998

Mean	7.71	594	89	6	0.05	280.5722		
Std. Devia	0.32	0	51	8	0	156.7476		
Minimum	7.08	594	24	1	0.05	97		
Maximum	8.18	594	179	29	0.05	577		
Median	7.77	594	86	2	0.05	328.1499		
Num. Valu	10	1	11	11	11	9		

VANGORDA PLATEAU SITE WATER QUALITY LISTING - 1998

STATION: V15, Sulphide cell sump, Grum Dump

	PH-F	FLOW	SO4-T	TSS	NH3-N	HARD-T (CaCO3)	ACIDITY (CaCO3)	ALK-T
Date	pH unit	L/s	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
12/01/98	7.4	0.5	112	61	<0.05			
17/03/98	7.84	0.5	39	271	<0.05			
18/05/98	7.7	0.5	90	366	<0.05			
29/06/98	7.82	0.5	35	<1	<0.05			
14/09/98		0.5	189	5	<0.05			
31/12/98	7.03	0.1	192	1213	<0.05			

JAN 1998 - DEC 1998

Mean	7.56	0.4	110	320	0.05
Std. Devia	0.34	0.2	69	463	0
Minimum	7.03	0.1	35	1	0.05
Maximum	7.84	0.5	192	1213	0.05
Median	7.7	0.5	101	166	0.05
Num. Valu	5	6	6	6	6

STATION: V17A, Runoff from ore transfer pad

	PH-F	FLOW	SO4-T	TSS	NH3-N	HARD-T	ACIDITY	ALK-T
Date	pH unit	L/s	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
18/05/98	7.2		9	9	<0.05			
30/06/98	7.46		14	2	<0.05			
14/09/98	7.53		7	<1	<0.05			

JAN 1998 - DEC 1998

Mean	7.4		10	4	0.05
Std. Devia	0.17		4	4	0
Minimum	7.2		7	1	0.05
Maximum	7.53		14	9	0.05
Median	7.46		9	2	0.05
Num. Valu	3		3	3	3

STATION: V18, Grum Dump, SE interceptor ditch

	PH-F	FLOW	SO4-T	TSS	NH3-N	HARD-T	ACIDITY	ALK-T
Date	pH unit	L/s	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
18/05/98			6	150	<0.05			

JAN 1998 - DEC 1998

Mean			6	150	0.05
Std. Devia			0	0	0
Minimum			6	150	0.05
Maximum			6	150	0.05
Median			6	150	0.05
Num. Valu			1	1	1

VANGORDA PLATEAU SITE WATER QUALITY LISTING - 1998

STATION: V20, Vangorda pit, NE interceptor ditch

	PH-F	FLOW	SO4-T	TSS	NH3-N	HARD-T (CaCO3)	ACIDITY (CaCO3)	ALK-T
Date	pH unit	L/s	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
18/05/98	7.74		75	3	<0.05			
JAN 1998 - DEC 1998								
Mean			75	3	0.05			
Std. Devia			0	0	0			
Minimum			75	3	0.05			
Maximum			75	3	0.05			
Median			75	3	0.05			
Num. Valu			1	1	1			

STATION: V21A, VG Dump Collector Ditch @ LCD

	PH-F	FLOW	SO4-T	TSS	NH3-N	HARD-T (CaCO3)	ACIDITY (CaCO3)	ALK-T
Date	pH unit	L/s	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
18/05/98	6.7	0.001	435	9	<0.05			pooled water
JAN 1998 - DEC 1998								
Mean	6.7	0.01	435	9	0.05			
Std. Devia	0	0	0	0	0			
Minimum	6.7	0.01	435	9	0.05			
Maximum	6.7	0.01	435	9	0.05			
Median	6.7	0.01	435	9	0.05			
Num. Valu	1	1	1	1	1			

STATION: V22, Vangorda pit water

	PH-F	FLOW	SO4-T	TSS	NH3-N	HARD-T (CaCO3)	ACIDITY (CaCO3)	ALK-T
Date	pH unit	L/s	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
13/01/98	7.42		417	65	75.7			pumping to LCD
14/09/98			872	9	2.36			
JAN 1998 - DEC 1998								
Mean	7.42		644	37	39.03			
Std. Devia	0		322	40	51.86			
Minimum	7.42		417	9	2.36			
Maximum	7.42		872	65	75.7			
Median	7.42		644	37	39.03			
Num. Valu	1		2	2	2			

VANGORDA PLATEAU SITE WATER QUALITY LISTING - 1998

STATION: V23, Grum Pit Water

	PH-F	FLOW	SO4-T	TSS	NH3-N	HARD-T (CaCO3)	ACIDITY (CaCO3)	ALK-T
Date	pH unit	L/s	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
14/09/98	7.65		201	6	2.6			
JAN 1998 - DEC 1998								
Mean	7.65		201	6	2.6			
Std. Devia	0		0	0	0			
Minimum	7.65		201	6	2.6			
Maximum	7.65		201	6	2.6			
Median	7.65		201	6	2.6			
Num. Valu	1		1	1	1			

STATION: V25BSP, Below Sheep Pond at the weir

	PH-F	FLOW	SO4-T	TSS	NH3-N	HARD-T (CaCO3)	ACIDITY (CaCO3)	ALK-T
Date	pH unit	L/s	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
06/01/98	7.13	0.1	486	34	2.65			
12/01/98	7.2	0.01	310	5	0.14			
17/03/98		0						no flow
14/04/98		0.1	333	11	<0.05			
19/04/98		0.5						visually clear water
07/05/98		3						visually clear water
18/05/98	7.4	10	63	137	<0.05			
31/05/98	7.4	5	68	8	<0.05			
09/06/98		13.2						
30/06/98	7.34	5	233	3	<0.05			weir repaired
25/07/98		0.13						bioassay
11/08/98	7.66	0.125	249	2	<0.05			
JAN 1998 - DEC 1998								
Mean	7.36	3.097	249	28.57	0.43			
Std. Devia	0.19	4.456	150	49.05	0.98			
Minimum	7.13	0	63	2	0.05			
Maximum	7.66	13.2	486	137	2.65			
Median	7.37	0.315	249	8	0.05			
Num. Valu	6	12	7	7	7			

VANGORDA PLATEAU SITE WATER QUALITY LISTING - 1998

STATION: V27, Vangorda Creek, just upstr. of Shrimp

	PH-F	FLOW	SO4-T	TSS	NH3-N	HARD-T (CaCO3)	ACIDITY (CaCO3)	ALK-T
Date	pH unit	L/s	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
29/05/98	6.66		45	7	<0.05			
29/06/98	7.72		43	1	<0.05	88		
14/09/98			18	2	<.05	56		

JAN 1998 - DEC 1998

Mean	7.19		35	3	0.05	72		
Std. Devia	0.75		15	3	0	23		
Minimum	6.66		18	1	0.05	56		
Maximum	7.72		45	7	0.05	88		
Median	7.19		43	2	0.05	72		
Num. Valu	2		3	3	3	2		

STATION: V29, Vangorda Dump drain #2

	PH-F	FLOW	SO4-T	TSS	NH3-N	HARD-T (CaCO3)	ACIDITY (CaCO3)	ALK-T
Date	pH unit	L/s	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
18/05/98	6.1	0.025	1236		0.32		172	249

JAN 1998 - DEC 1998

Mean	6.1	0.025	1236		0.32		172	249
Std. Devia	0	0	0		0		0	0
Minimum	6.1	0.025	1236		0.32		172	249
Maximum	6.1	0.025	1236		0.32		172	249
Median	6.1	0.025	1236		0.32		172	249
Num. Valu	1	1	1		1		1	1

STATION: V30, Vangorda Dump drain #3

	PH-F	FLOW	SO4-T	TSS	NH3-N	HARD-T (CaCO3)	ACIDITY (CaCO3)	ALK-T
Date	pH unit	L/s	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
18/05/98	6.1	0.083	2634		<0.05		933	177
29/06/98	5.95	0.01	2757		6.72			
14/09/98		0.007	2637		7.2			
31/12/98		0						no water

JAN 1998 - DEC 1998

Mean	6.02	0.025	2676		4.66		933	177
Std. Devia	0.11	0.039	70		4		0	0
Minimum	5.95	0	2634		0.05		933	177
Maximum	6.1	0.083	2757		7.2		933	177
Median	6.02	0.008	2637		6.72		933	177
Num. Valu	2	4	3		3		1	1

VANGORDA PLATEAU SITE WATER QUALITY LISTING - 1998

STATION: V31, Vangorda Dump drain #4

	PH-F	FLOW	SO4-T	TSS	NH3-N	HARD-T (CaCO3)	ACIDITY (CaCO3)	ALK-T
Date	pH unit	L/s	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
18/05/98	7.1	0.017	2172		2.73		190	26320
JAN 1998 - DEC 1998								
Mean	7.1	0.017	2172		2.73		190	26320
Std. Devia	0	0	0		0		0	0
Minimum	7.1	0.017	2172		2.73		190	26320
Maximum	7.1	0.017	2172		2.73		190	26320
Median	7.1	0.017	2172		2.73		190	26320
Num. Valu	1	1	1		1		1	1

STATION: V32, Vangorda Dump drain #5

	PH-F	FLOW	SO4-T	TSS	NH3-N	HARD-T (CaCO3)	ACIDITY (CaCO3)	ALK-T
Date	pH unit	L/s	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
18/05/98	4.7	0.008	3003		<0.05		2514	<5
29/06/98	3.37	0.03	3961		<0.05			
14/09/98	3.51	0.02	10947		<0.05			
JAN 1998 - DEC 1998								
Mean	3.86	0.019	5970		0.05		2514	5
Std. Devia	0.73	0.011	4336		0		0	0
Minimum	3.37	0.008	3003		0.05		2514	5
Maximum	4.7	0.03	10947		0.05		2514	5
Median	3.51	0.02	3961		0.05		2514	5
Num. Valu	3	3	3		3		1	1

STATION: V33, Vangorda Dump drain #6

	PH-F	FLOW	SO4-T	TSS	NH3-N	HARD-T (CaCO3)	ACIDITY (CaCO3)	ALK-T
Date	pH unit	L/s	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
18/05/98	6	0.077	909		0.38		72	66
15/09/98	7.03	0.004	3045		0.28			
JAN 1998 - DEC 1998								
Mean	6.52	0.04	1977		0.33		72	66
Std. Devia	0.73	0.052	1510		0.07		0	0
Minimum	6	0.004	909		0.28		72	66
Maximum	7.03	0.077	3045		0.38		72	66
Median	6.52	0.04	1977		0.33		72	66
Num. Valu	2	2	2		2		1	1

VANGORDA PLATEAU SITE WATER QUALITY LISTING - 1998

STATION: V34, groundwater well GW94-01

	PH-F	SWL	SO4-T	TSS	NH3-N	HARD-T (CaCO3)	ACIDITY (CaCO3)	ALK-T
Date	pH unit	meters	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
31/05/98	7	6.72	31		<0.05			
14/09/98		6.67	34		0.05			
31/12/98	7.35	6.7	27		<0.05			

JAN 1998 - DEC 1998

Mean	7.17	6.7	31		0.05			
Std. Devia	0.25	0.03	4		0			
Minimum	7	6.67	27		0.05			
Maximum	7.35	6.72	34		0.05			
Median	7.17	6.7	31		0.05			
Num. Valu	2	3	3		3			

STATION: V35, groundwater well GW94-02

	PH-F	SWL	SO4-T	TSS	NH3-N	HARD-T (CaCO3)	ACIDITY (CaCO3)	ALK-T
Date	pH unit	meters	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
31/05/98	6.82	8.6	147		0.07			
14/09/98		8.85	648		0.12			
31/12/98	6.99	9.06	805		0.1			

JAN 1998 - DEC 1998

Mean	6.9	8.84	533		0.1			
Std. Devia	0.12	0.23	344		0.03			
Minimum	6.82	8.6	147		0.07			
Maximum	6.99	9.06	805		0.12			
Median	6.9	8.85	648		0.1			
Num. Valu	2	3	3		3			

STATION: V36, groundwater well GW94-03

	PH-F	SWL	SO4-T	TSS	NH3-N	HARD-T	ACIDITY	ALK-T
Date	pH unit	meters	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
31/05/98	6.92	9.73	350		0.17			
14/09/98		9.52	245		0.2			
31/12/98	6.88	9.91	279		0.35			

JAN 1998 - DEC 1998

Mean	6.9	9.72	291		0.24			
Std. Devia	0.03	0.2	54		0.1			
Minimum	6.88	9.52	245		0.17			
Maximum	6.92	9.91	350		0.35			
Median	6.9	9.73	279		0.2			
Num. Valu	2	3	3		3			

VANGORDA PLATEAU SITE WATER QUALITY LISTING - 1998

STATION: V37, groundwater well GW94-04

	PH-F	SWL	SO4-T	TSS	NH3-N	HARD-T (CaCO3)	ACIDITY (CaCO3)	ALK-T
Date	pH unit	meters	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
31/05/98	7.36	9.59	54		0.95			
14/09/98		9.1	65		0.93			
31/12/98	7.25	9.23	74		0.08			

JAN 1998 - DEC 1998

Mean	7.31	9.31	64		0.65			
Std. Devia	0.08	0.25	10		0.5			
Minimum	7.25	9.1	54		0.08			
Maximum	7.36	9.59	74		0.95			
Median	7.31	9.23	65		0.93			
Num. Valu	2	3	3		3			

STATION: V39, Vangorda till berm, P-94-01A

	PH-F	SWL	SO4-T	TSS	NH3-N	HARD-T (CaCO3)	ACIDITY (CaCO3)	ALK-T
Date	pH unit	meters	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
31/05/98	6.99	9.52	116		<0.05			
15/09/98		9.98	91		0.08			

JAN 1998 - DEC 1998

Mean	6.99	9.75	104		0.06			
Std. Devia	0	0.33	18		0.02			
Minimum	6.99	9.52	91		0.05			
Maximum	6.99	9.98	116		0.08			
Median	6.99	9.75	104		0.06			
Num. Valu	1	2	2		2			

STATION: V40, Vangorda till berm, P-94-01B

	PH-F	SWL	SO4-T	TSS	NH3-N	HARD-T (CaCO3)	ACIDITY (CaCO3)	ALK-T
Date	pH unit	meters	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
31/05/98		5.25	268		<0.05			
15/09/98		5.11						

JAN 1998 - DEC 1998

Mean		5.18	268		0.05			
Std. Devia		0.1	0		0			
Minimum		5.11	268		0.05			
Maximum		5.25	268		0.05			
Median		5.18	268		0.05			
Num. Valu		2	1		1			

VANGORDA PLATEAU SITE WATER QUALITY LISTING - 1998

STATION: V41, Vangorda till berm, P-94-02A

	PH-F	SWL	SO4-T	TSS	NH3-N	HARD-T (CaCO3)	ACIDITY (CaCO3)	ALK-T
Date	pH unit	meters	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
31/05/98	7.05	8.05	42		<0.05			
15/09/98		7.93	40		<0.05			

JAN 1998 - DEC 1998

Mean	7.05	7.99	41		0.05			
Std. Devia	0	0.08	1		0			
Minimum	7.05	7.93	40		0.05			
Maximum	7.05	8.05	42		0.05			
Median	7.05	7.99	41		0.05			
Num. Valu	1	2	2		2			

STATION: V43, Vangorda till berm, P-94-02C

	PH-F	SWL	SO4-T	TSS	NH3-N	HARD-T (CaCO3)	ACIDITY (CaCO3)	ALK-T
Date	pH unit	meters	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
31/05/98	7.03	9.2	54		<0.05			
15/09/98		9.19	43		0.05			

JAN 1998 - DEC 1998

Mean	7.03	9.19	48		0.05			
Std. Devia	0	0.01	8		0			
Minimum	7.03	9.19	43		0.05			
Maximum	7.03	9.2	54		0.05			
Median	7.03	9.19	48		0.05			
Num. Valu	1	2	2		2			

STATION: 96-9A, Groundwater at the toe of Grum dump

	PH-F	SWL	SO4-T	TSS	NH3-N	HARD-T (CaCO3)	ACIDITY (CaCO3)	ALK-T
Date	pH unit	meters	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
31/05/98	7.26	5.6	102					
15/09/98		5.82	203		0.09			
31/12/98		5.47						frozen

JAN 1998 - DEC 1998

Mean	7.26	5.63	152		0.09			
Std. Devia	0	0.18	71		0			
Minimum	7.26	5.47	102		0.09			
Maximum	7.26	5.82	203		0.09			
Median	7.26	5.6	152		0.09			
Num. Valu	1	3	2		1			

VANGORDA PLATEAU SITE WATER QUALITY LISTING - 1998

STATION: 96-9B, Groundwater at toe of Grum dump

	PH-F	SWL	SO4-T	TSS	NH3-N	HARD-T (CaCO3)	ACIDITY (CaCO3)	ALK-T
Date	pH unit	meters	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
31/05/98	7.31	0.49	96					
15/09/98		0	155		0.25			flowing slowly
31/12/98		0						frozen
JAN 1998 - DEC 1998								
Mean	7.31	0.16	126		0.25			
Std. Devia	0	0.28	42		0			
Minimum	7.31	0	96		0.25			
Maximum	7.31	0.49	155		0.25			
Median	7.31	0	126		0.25			
Num. Valu	1	3	2		1			

STATION: LCD, Little Creek Dam Pond Water

	PH-F	SO4-T	TSS	NH3-N
Date	pH unit	mg/L	mg/L	mg/L
18/05/98	7	144	7	1.15
JAN 1998 - DEC 1998				
Mean	7	144	7	1.15
Std. Devia	0	0	0	0
Minimum	7	144	7	1.15
Maximum	7	144	7	1.15
Median	7	144	7	1.15
Num. Valu	1	1	1	1

VANGORDA PLATEAU SITE WATER QUALITY LISTING - 1998

STATION: V1, Vangorda Creek, upstrm of mine & Blind Cr. Rd

Date	AG-T mg/L	AL-T mg/L	AS-T mg/L	B-T mg/L	BA-T mg/L	BE-T mg/L	BI-T mg/L	CA-T mg/L	CD-T mg/L	CO-T mg/L	CR-T mg/L	CU-T mg/L	FE-T mg/L	HG-T mg/L	K-T mg/L	LA-T mg/L	MG-T mg/L	MN-T mg/L	MO-T mg/L	NA-T mg/L	NI-T mg/L	P-T mg/L	PB-T mg/L	S-T mg/L	SB-T mg/L	SE-T mg/L	SI-T mg/L	SN-T mg/L	SR-T mg/L	TI-T mg/L	V-T mg/L	W-T mg/L	ZN-T mg/L
18/05/98	<.003	0.15	0.02	0.23	0.028	<.001	<.04	7.1	<.002	<.005	0.02	0.027	0.09		1	<.005	1.3	<.01	<.002	2	0.01	0.27	<.02	8	<.03	<.03	1.6	<.01	0.033	<.005	<.005	<.03	0.02
30/06/98	<.003	<.05	<.02	<.05	0.152	<.001	<.04	7.5	<.002	<.005	0.008	<.002	<.01		<1	<.005	1.4	<.01	0.005	2	<.005	2.37	<.02	6	<.03	<.03	4	<.01	0.048	0.008	0.008	<.03	<.01
14/09/98	<.003	<.05	<.02	<.05	0.078	<.001	<.04	9.1	<.002	0.01	<.005	0.016	0.61		<1	<.005	1.5	<.01	0.007	2	0.011	<.04	<.02	3.2	<.03	<.03	3.4	<.01	0.058	0.038	<.005	<.03	0.02
31/12/98	<.003	0.06	<.005	0.21	0.058	<.001	<.04	18.5	<.001	0.009	<.005	0.057	0.29		<1	<.005	2.8	<.01	0.033	3	<.005	1.95	<.01	4	<.03	<.03	4.4	<.01	0.102	0.013	<.005	<.03	0.05
JAN 1998 - DEC 1998																																	
Mean	0.003	0.08	0.016	0.13	0.079	0.001	0.04	10.6	0.002	0.007	0.009	0.026	0.25		1	0.005	1.7	0.01	0.012	2	0.008	1.16	0.02	5.3	0.03	0.03	3.4	0.01	0.06	0.016	0.006	0.03	0.02
Std. Devia	0	0.05	0.007	0.1	0.053	0	0	5.4	0.001	0.003	0.007	0.023	0.27		0	0	0.7	0	0.014	0	0.003	1.17	0	2.2	0	0	1.2	0	0.03	0.015	0.002	0	0.02
Minimum	0.003	0.05	0.005	0.05	0.028	0.001	0.04	7.1	0.001	0.005	0.005	0.002	0.01		1	0.005	1.3	0.01	0.002	2	0.005	0.04	0.01	3.2	0.03	0.03	1.6	0.01	0.033	0.005	0.005	0.03	0.01
Maximum	0.003	0.15	0.02	0.23	0.152	0.001	0.04	18.5	0.002	0.01	0.02	0.057	0.61		1	0.005	2.8	0.01	0.033	3	0.011	2.37	0.02	8	0.03	0.03	4.4	0.01	0.102	0.038	0.008	0.03	0.05
Median	0.003	0.05	0.02	0.13	0.068	0.001	0.04	8.3	0.002	0.007	0.007	0.022	0.19		1	0.005	1.4	0.01	0.006	2	0.007	1.11	0.02	5	0.03	0.03	3.7	0.01	0.053	0.011	0.005	0.03	0.02
Num. Valu	4	4	4	4	4	4	4	4	4	4	4	4	4		4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4	4

Date	AG-D mg/L	AL-D mg/L	AS-D mg/L	B-D mg/L	BA-D mg/L	BE-D mg/L	BI-D mg/L	CA-D mg/L	CD-D mg/L	CO-D mg/L	CR-D mg/L	CU-D mg/L	FE-D mg/L	HG-D mg/L	K-D mg/L	LA-D mg/L	MG-D mg/L	MN-D mg/L	MO-D mg/L	NA-D mg/L	NI-D mg/L	P-D mg/L	PB-D mg/L	S-D mg/L	SB-D mg/L	SE-D mg/L	SI-D mg/L	SN-D mg/L	SR-D mg/L	TI-D mg/L	V-D mg/L	W-D mg/L	ZN-D mg/L
31/12/98	<.003	<.05	<.005	<.05	0.011	<.001	<.04	16.6	<.001	0.013	<.005	<.002	<.01		<1	<.005	3.3	<.01	0.014	2	<.005	<.04	<.01	4	<.03	<.03	3.7	<.01	0.114	<.005	<.005	<.03	<.01
JAN 1998 - DEC 1998																																	
Mean	0.003	0.05	0.005	0.05	0.011	0.001	0.04	16.6	0.001	0.013	0.005	0.002	0.01		1	0.005	3.3	0.01	0.014	2	0.005	0.04	0.01	4	0.03	0.03	3.7	0.01	0.114	0.005	0.005	0.03	0.01
Std Devia	0	0	0	0	0	0	0	0	0	0	0	0	0		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Minimum	0.003	0.05	0.005	0.05	0.011	0.001	0.04	16.6	0.001	0.013	0.005	0.002	0.01		1	0.005	3.3	0.01	0.014	2	0.005	0.04	0.01	4	0.03	0.03	3.7	0.01	0.114	0.005	0.005	0.03	0.01
Maximum	0.003	0.05	0.005	0.05	0.011	0.001	0.04	16.6	0.001	0.013	0.005	0.002	0.01		1	0.005	3.3	0.01	0.014	2	0.005	0.04	0.01	4	0.03	0.03	3.7	0.01	0.114	0.005	0.005	0.03	0.01
Median	0.003	0.05	0.005	0.05	0.011	0.001	0.04	16.6	0.001	0.013	0.005	0.002	0.01		1	0.005	3.3	0.01	0.014	2	0.005	0.04	0.01	4	0.03	0.03	3.7	0.01	0.114	0.005	0.005	0.03	0.01
Num Valu	1	1	1	1	1	1	1	1	1	1	1	1	1		1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	

STATION: V2, Grum Creek, upstr. of Vangorda Ck

Date	AG-T mg/L	AL-T mg/L	AS-T mg/L	B-T mg/L	BA-T mg/L	BE-T mg/L	BI-T mg/L	CA-T mg/L	CD-T mg/L	CO-T mg/L	CR-T mg/L	CU-T mg/L	FE-T mg/L	HG-T mg/L	K-T mg/L	LA-T mg/L	MG-T mg/L	MN-T mg/L	MO-T mg/L	NA-T mg/L	NI-T mg/L	P-T mg/L	PB-T mg/L	S-T mg/L	SB-T mg/L	SE-T mg/L	SI-T mg/L	SN-T mg/L	SR-T mg/L	TI-T mg/L	V-T mg/L	W-T mg/L	ZN-T mg/L
12/01/98	<.003	<.05	<.02	<.05	0.295	<.001	<.04	78.7	<.002	0.007	<.005	0.008	0.21		<1	<.005	19.8	<.01	<.002	4	<.005	<.04	<.02	27	<.03	<.03	3.4	<.01	0.392	<.005	<.005	<.03	0.02
17/03/98	<.003	0.14	<.02	<.05	0.351	<.001	<.04	103.1	<.002	<.005	0.026	0.018	0.18		1	0.006	29.2	<.01	0.01	8	<.005	<.04	<.02	28	<.03	<.03	4.6	<.01	0.523	0.008	0.018	<.03	<.01
18/05/98	<.003	0.31	0.04	0.22	0.201	<.001	<.04	86.9	<.002	<.005	0.008	0.032	0.19		1	<.005	22.5	0.02	<.002	6	0.007	0.1	<.02	78	0.08	<.03	4.5	<.01	0.415	<.005	<.005	<.03	0.1
29/06/98	<.003	0.11	0.03	<.05	0.333	0.001	<.04	94.6	<.002	0.009	0.066	0.022	0.1		2	<.005	23.8	<.01	0.012	6	0.008	<.04	<.02	38	<.03	<.03	5.2	<.01	0.466	0.041	<.005	<.03	0.01
14/09/98	<.003	0.1	<.02	0.06	0.32	<.001	<.04	106	<.002	0.009	<.005	0.026	0.23		2	<.005	28.7	0.04	0.008	8	0.02	1.18	<.02	41.6	<.03	<.03	5.1	<.01	0.556	0.028	<.005	<.03	0.03
31/12/98	<.003	0.22	<.005	0.28	0.294	<.001	<.04	133.8	<.001	0.012	<.005	0.057	0.38		3	<.005	41.4	<.01	0.008	11	<.005	13.49	<.01	51	<.03	<.03	6.4	<.01	0.705	0.021	<.005	<.03	0.04
JAN 1998 - DEC 1998																																	
Mean	0.003	0.16	0.022	0.12	0.299	0.001	0.04	100.5	0.002	0.008	0.019	0.027	0.21		2	0.005	27.6	0.02	0.007	7	0.008	2.48	0.02	43.9	0.04	0.03	4.9	0.01	0.509	0.018	0.007	0.03	0.03
Std. Devia	0	0.09	0.012	0.1	0.053	0	0	19.2	0	0.003	0.024	0.017	0.09		1	0	7.7	0.01	0.004	2	0.006	5.41	0	18.9	0.02	0	1	0	0.114	0.015	0.005	0	0.03
Minimum	0.003	0.05	0.005	0.05	0.201	0.001	0.04	78.7	0.001	0.005	0.005	0.008	0.1		1	0.005	19.8	0.01	0.002	4	0.005	0.04	0.01	27	0.03	0.03	3.4	0.01	0.392	0.005	0.005	0.03	0.01
Maximum	0.003	0.31	0.04	0.28	0.351	0.001	0.04	133.8	0.002	0.012	0.066	0.057	0.38		3	0.006	41.4	0.04	0.012	11	0.02	13.49	0.02	78	0.08	0.03	6.4	0.01	0.705	0.041	0.018	0.03	0.1
Median	0.003	0.12	0.02	0.05	0.307	0.001	0.04	98.8	0.002	0.008	0.007	0.024	0.2		2	0.005	26.2	0.01	0.008	7	0.006	0.07	0.02	39.8	0.03	0.03	4.8	0.01	0.494	0.015	0.005	0.03	0.02
Num. Valu	6	6	6	6	6	6	6	6	6	6	6	6	6		6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6

STATION: V2A, Grum Creek Diversion to Moose Pond

Date	AG-T mg/L	AL-T mg/L	AS-T mg/L	B-T mg/L	BA-T mg/L	BE-T mg/L	BI-T mg/L	CA-T mg/L	CD-T mg/L	CO-T mg/L	CR-T mg/L	CU-T mg/L	FE-T mg/L	HG-T mg/L	K-T mg/L	LA-T mg/L	MG-T mg/L	MN-T mg/L	MO-T mg/L	NA-T mg/L	NI-T mg/L	P-T mg/L	PB-T mg/L	S-T mg/L	SB-T mg/L	SE-T mg/L	SI-T mg/L	SN-T mg/L	SR-T mg/L	TI-T mg/L	V-T mg/L	W-T mg/L	ZN-T mg/L																													
29/06/98	<.003	<.05	<.02	<.05	0.268	<.001	<.04	105.8	<.002	<.005	0.052	0.019	<.01		2	<.005	28.2	<.01	0.004	8	<.005	<.04	<.02	41	<.03	<.03	5.7	<.01	0.497	0.019	0.011	<.03	0.01																													
14/09/98	<.003	0.1	<.02	<.05	0.186	<.001	<.04	93.5	<.002	<.005	0.031	0.028	0.17		2	<.005	23.9	<.01	0.004	6	<.005	0.98	<.02	38.6	<.03	<.03	4.3	<.01	0.43	0.022	<.005	<.03	0.02																													
JAN 1998 - DEC 1998																																																														
Mean	0.003	0.08	0.02	0.05	0.227	0.001	0.04	99.7	0.002	0.005	0.042	0.024	0.09		2	0.005	26.1	0.01	0.004	7	0.005	0.51	0.02	39.8	0.03	0.03	5	0.01	0.464	0.02	0.008	0.03	0.01																													
Std. Devia	0	0.04	0	0	0.058	0	0	8.7	0	0	0.015	0.006	0.11		0	0	3.9	0	0	1	0	0.66	0	1.7	0	0	1	0	0.047	0.002	0.004	0	0.01																													
Minimum	0.003	0.05	0.02	0.05	0.186	0.001	0.04	93.5	0.002	0.005	0.031	0.019	0.01		2	0.005	23.9	0.01	0.004	6	0.005	0.04	0.02	38.6	0.03	0.03	4.3	0.01	0.43	0.019	0.005	0.03	0.01																													
Maximum	0.003	0.1	0.02	0.05	0.268	0.001	0.04	105.8	0.002	0.005	0.052	0.028	0.17		2	0.005	28.2	0.01	0.004	8	0.005	0.98	0.02	41	0.03	0.03	5.7	0.01	0.497	0.022	0.011	0.03	0.02																													
Median	0.003	0.08	0.02	0.05	0.227	0.001	0.04	99.7	0.002	0.005	0.042	0.024	0.09		2	0.005	26.1	0.01	0.004	7	0.005	0.51	0.02	39.8	0.03	0.03	5	0.01	0.464	0.02	0.008	0.03	0.01																													
Num. Valu	2	2	2	2	2	2	2	2	2	2	2	2	2		2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2																													

STATION: V4, Shrimp Creek, upstr. of Vangorda Creek

STATION: V5, west fork Vangorda Creek[illegible]

VANGORDA PLATEAU SITE WATER QUALITY LISTING - 1998

STATION: V6A, AEX Creek

	AG-T	AL-T	AS-T	B-T	BA-T	BE-T	BI-T	CA-T	CD-T	CO-T	CR-T	CU-T	FE-T	HG-T	K-T	LA-T	MG-T	MN-T	MO-T	NA-T	NI-T	P-T	PB-T	S-T	SB-T	SE-T	SI-T	SN-T	SR-T	TI-T	V-T	W-T	ZN-T
Date	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
13/01/98	<.003	0.31	<.02	<.05	0.252	<.001	<.04	39.3	<.002	0.023	<.005	0.008	1.5		<1	<.005	7.8	0.04	0.002	2	<.005	<.04	0.13	7	<.03	<.03	3.5	<.01	0.194	0.006	<.005	<.03	0.34
17/03/98	<.003	<.05	<.02	<.05	0.12	<.001	<.04	46.8	<.002	<.005	0.011	0.012	<.01		<1	<.005	9.8	<.01	<.002	3	<.005	<.04	<.02	7	<.03	<.03	3.9	<.01	0.232	<.005	0.014	<.03	<.01
19/05/98	<.003	0.57	<.02	0.21	0.045	<.001	<.04	15.3	<.002	<.005	0.028	0.026	0.99		<1	0.021	3.3	0.08	<.002	2	<.005	1.5	<.02	3	0.07	<.03	2.8	<.01	0.07	<.005	<.005	<.03	0.08
30/06/98	<.003	0.06	<.02	<.05	0.147	<.001	<.04	22.7	<.002	<.005	0.066	0.007	0.13		<1	<.005	4.3	<.01	<.002	2	<.005	<.04	<.02	29	<.03	<.03	5.4	<.01	0.117	0.011	<.005	<.03	0.01
15/09/98	<.003	<.05	<.02	<.05	0.109	<.001	<.04	24.8	<.002	<.005	<.005	0.016	0.17		<1	<.005	4.5	0.01	<.002	2	<.005	0.33	<.02	4.1	<.03	<.03	4.3	<.01	0.126	0.017	<.005	<.03	0.02
31/12/98	<.003	0.11	<.005	0.2	0.097	<.001	<.04	49.8	<.001	<.005	<.005	0.046	0.26		2	0.027	10.4	0.01	<.002	3	<.005	<.04	<.01	9	<.03	<.03	5.1	<.01	0.259	0.011	<.005	<.03	0.05
JAN 1998 - DEC 1998																																	
Mean	0.003	0.19	0.017	0.1	0.128	0.001	0.04	33.1	0.002	0.008	0.02	0.019	0.51		1	0.011	6.7	0.03	0.002	2	0.005	0.33	0.04	9.8	0.04	0.03	4.2	0.01	0.166	0.009	0.006	0.03	0.09
Std. Devia	0	0.21	0.006	0.08	0.059	0	0	14.1	0	0.007	0.024	0.015	0.6		0	0.01	3.1	0.03	0	1	0	0.58	0.05	9.6	0.02	0	1	0	0.073	0.005	0.004	0	0.13
Minimum	0.003	0.05	0.005	0.05	0.045	0.001	0.04	15.3	0.001	0.005	0.005	0.007	0.01		1	0.005	3.3	0.01	0.002	2	0.005	0.04	0.01	3	0.03	0.03	2.8	0.01	0.07	0.005	0.005	0.03	0.01
Maximum	0.003	0.57	0.02	0.21	0.252	0.001	0.04	49.8	0.002	0.023	0.066	0.046	1.5		2	0.027	10.4	0.08	0.002	3	0.005	1.5	0.13	29	0.07	0.03	5.4	0.01	0.259	0.017	0.014	0.03	0.34
Median	0.003	0.08	0.02	0.05	0.114	0.001	0.04	32	0.002	0.005	0.008	0.014	0.21		1	0.005	6.2	0.01	0.002	2	0.005	0.04	0.02	7	0.03	0.03	4.1	0.01	0.16	0.008	0.005	0.03	0.04
Num. Valu	6	6	6	6	6	6	6	6	6	6	6	6	6		6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6

STATION: VGMAIN, Main Fork Vangorda Creek

	AG-T	AL-T	AS-T	B-T	BA-T	BE-T	BI-T	CA-T	CD-T	CO-T	CR-T	CU-T	FE-T	HG-T	K-T	LA-T	MG-T	MN-T	MO-T	NA-T	NI-T	P-T	PB-T	S-T	SB-T	SE-T	SI-T	SN-T	SR-T	TI-T	V-T	W-T	ZN-T
Date	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
17/03/98	<.003	0.08	<.02	<.05	0.162	<.001	<.04	73.2	<.002	<.005	0.018	0.013	0.11		<1	<.005	31.4	0.01	<.002	6	0.01	<.04	<.02	107	<.03	<.03	3.9	<.01	0.342	<.005	0.015	<.03	0.05
14/04/98	<.003	0.11	<.02	<.05	0.18	<.001	<.04	67.1	<.002	<.005	0.027	0.038	0.1		<1	<.005	28	0.02	0.004	6	0.009	<.04	<.02	32	<.03	<.03	3.9	<.01	0.342	0.007	<.005	<.03	0.32
19/05/98	<.003	0.67	<.02	0.2	0.059	<.001	<.04	21.6	<.002	<.005	0.028	0.035	1.11		1	<.005	7.6	0.04	<.002	2	0.011	0.79	<.02	7	0.04	<.03	3	<.01	0.097	0.009	<.005	<.03	0.08
30/06/98	<.003	<.05	<.02	0.5	0.144	<.001	<.04	27.9	<.002	<.005	0.027	0.008	<.01		<1	<.005	9.6	<.01	0.003	3	<.005	2.49	<.02	13	<.03	<.03	4	<.01	0.14	0.011	<.005	<.03	0.03
21/07/98	<.003	<.05	<.02	<.05	0.121	<.001	<.04	37.6	<.002	<.005	0.037	0.03	<.01		<1	0.015	13.3	<.01	<.002	4	0.006	<.04	<.02	8	<.03	<.03	2.8	<.01	0.181	<.005	<.005	<.03	0.04
15/09/98	<.003	<.05	<.02	<.05	0.096	<.001	<.04	27.4	<.002	<.005	<.005	0.015	0.04		1	<.005	9.6	<.01	0.007	3	<.005	<.04	<.02	11.4	<.03	<.03	2.9	<.01	0.14	0.016	<.005	<.03	0.01
19/10/98	<.003	0.09	<.02	0.11	0.055	<.001	<.04	39.1	<.002	<.005	<.005	0.013	0.08		<1	<.005	14	<.01	<.002	4	0.01	2.22	<.02	16	<.03	<.03	3	<.01	0.183	0.022	0.006	<.03	0.03
17/11/98	<.003	<.05	<.005	<.05	0.168	<.001	<.04	65.5	<.001	<.005	0.023	0.019	0.05		2	<.005	27.2	<.01	0.007	6	<.005	1.08	<.01	29	<.03	<.03	3.4	<.01	0.278	0.009	<.005	<.03	0.04
31/12/98	<.003	0.13	<.005	0.24	0.095	<.001	<.04	78.4	<.001	<.005	<.005	0.047	0.17		2	<.005	42.6	<.01	0.007	7	0.012	<.04	<.01	50	<.03	<.03	3.9	<.01	0.446	0.012	<.005	<.03	0.02
JAN 1998 - DEC 1998																																	
Mean	0.003	0.14	0.017	0.09	0.12	0.001	0.04	48.6	0.002	0.005	0.019	0.024	0.19		1	0.006	20.4	0.01	0.004	5	0.009	0.75	0.02	30.4	0.03	0.03	3.4	0.01	0.239	0.011	0.006	0.03	0.07
Std. Devia	0	0.2	0.007	0.07	0.047	0	0	22.2	0	0	0.012	0.014	0.35		0	0.003	12.3	0.01	0.002	2	0.003	0.99	0	32	0	0	0.5	0	0.118	0.006	0.003	0	0.1
Minimum	0.003	0.05	0.005	0.05	0.055	0.001	0.04	21.6	0.001	0.005	0.005	0.008	0.01		1	0.005	7.6	0.01	0.002	2	0.005	0.04	0.01	7	0.03	0.03	2.8	0.01	0.097	0.005	0.005	0.03	0.01
Maximum	0.003	0.67	0.02	0.24	0.18	0.001	0.04	78.4	0.002	0.005	0.037	0.047	1.11		2	0.015	42.6	0.04	0.007	7	0.012	2.49	0.02	107	0.04	0.03	4	0.01	0.446	0.022	0.015	0.03	0.32
Median	0.003	0.08	0.02	0.05	0.121	0.001	0.04	39.1	0.002	0.005	0.023	0.019	0.08		1	0.005	14	0.01	0.003	4	0.009	0.04	0.02	16	0.03	0.03	3.4	0.01	0.183	0.009	0.005	0.03	0.04
Num. Valu	9	9	9	9	9	9	9	9	9	9	9	9	9		9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9

	AG-D	AL-D	AS-D	B-D	BA-D	BE-D	BI-D	CA-D	CD-D	CO-D	CR-D	CU-D	FE-D	HG-D	K-D	LA-D	MG-D	MN-D	MO-D	NA-D	NI-D	P-D	PB-D	S-D	SB-D	SE-D	SI-D	SN-D	SR-D	TI-D	V-D	W-D	ZN-D
Date	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
31/12/98	<.003	<.05	<.005	<.05	0.04	<.001	<.04	77.1	<.001	<.005	<.005	0.005	<.01		2	<.005	42.1	<.01	0.005	6	<.005	1.71	<.01	56	<.03	<.03	3.5	<.01	0.439	<.005	<.005	<.03	<.01
JAN 1998 - DEC 1998																																	
Mean	0.003	0.05	0.005	0.05	0.04	0.001	0.04	77.1	0.001	0.005	0.005	0.005	0.01		2	0.005	42.1	0.01	0.005	6	0.005	1.71	0.01	56	0.03	0.03	3.5	0.01	0.439	0.005	0.005	0.03	0.01
Std. Devia	0	0	0	0	0	0	0	0	0	0	0	0	0		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Minimum	0.003	0.05	0.005	0.05	0.04	0.001	0.04	77.1	0.001	0.005	0.005	0.005	0.01		2	0.005	42.1	0.01	0.005	6	0.005	1.71	0.01	56	0.03	0.03	3.5	0.01	0.439	0.005	0.005	0.03	0.01
Maximum	0.003	0.05	0.005	0.05	0.04	0.001	0.04	77.1	0.001	0.005	0.005	0.005	0.01		2	0.005	42.1	0.01	0.005	6	0.005	1.71	0.01	56	0.03	0.03	3.5	0.01	0.439	0.005	0.005	0.03	0.01
Median	0.003	0.05	0.005	0.05	0.04	0.001	0.04	77.1	0.001	0.005	0.005	0.005	0.01		2	0.005	42.1	0.01	0.005	6	0.005	1.71	0.01	56	0.03	0.03	3.5	0.01	0.439	0.005	0.005	0.03	0.01
Num. Valu	1	1	1	1	1	1	1	1	1	1	1	1	1		1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	

VANGORDA PLATEAU SITE WATER QUALITY LISTING - 1998

STATION: V8, lower Vangorda Creek

Date	AG-T mg/L	AL-T mg/L	AS-T mg/L	B-T mg/L	BA-T mg/L	BE-T mg/L	BI-T mg/L	CA-T mg/L	CD-T mg/L	CO-T mg/L	CR-T mg/L	CU-T mg/L	FE-T mg/L	HG-T mg/L	K-T mg/L	LA-T mg/L	MG-T mg/L	MN-T mg/L	MO-T mg/L	NA-T mg/L	NI-T mg/L	P-T mg/L	PB-T mg/L	S-T mg/L	SB-T mg/L	SE-T mg/L	SI-T mg/L	SN-T mg/L	SR-T mg/L	TI-T mg/L	V-T mg/L	W-T mg/L	ZN-T mg/L
13/01/98	<.003	<.05	<.02	<.05	0.173	<.001	<.04	77.7	<.002	0.013	<.005	0.006	<.01	1	<.005	32.5	0.1	0.006	4	<.005	<.04	<.02	44	<.03	<.03	2.9	<.01	0.37	<.005	<.005	<.03	0.02	
17/03/98	<.003	0.08	<.02	<.05	0.166	<.001	<.04	85.8	<.002	<.005	0.019	0.015	<.01	<.1	0.005	40.6	0.14	0.003	7	<.005	<.04	<.02	46	<.03	<.03	4.2	<.01	0.402	<.005	0.016	<.03	0.03	
14/04/98	<.003	0.09	<.02	<.05	0.141	<.001	<.04	77.7	0.002	<.005	0.029	0.037	<.01	<.1	<.005	36	0.1	0.003	6	0.007	<.04	<.02	41	<.03	<.03	4	<.01	0.387	0.006	<.005	<.03	0.26	
19/05/98	<.003	0.45	<.02	0.18	0.053	<.001	<.04	24.8	<.002	<.005	0.038	0.031	0.75	1	<.005	9.3	0.04	<.002	2	0.015	0.87	0.04	8	0.04	<.03	2.4	<.01	0.109	0.006	0.019	<.03	0.07	
30/06/98	<.003	<.05	<.02	<.05	0.163	<.001	<.04	35.3	<.002	<.005	0.025	0.008	<.01	<.1	0.017	13.7	<.01	<.002	3	<.005	0.54	<.02	29	<.03	<.03	4.4	<.01	0.177	0.009	0.006	<.03	0.02	
21/07/98	<.003	<.05	<.02	<.05	0.131	<.001	<.04	50.2	<.002	<.005	0.038	0.036	0.02	<.1	0.022	19.8	0.02	<.002	5	0.01	<.04	<.02	9	<.03	<.03	3.3	<.01	0.234	<.005	<.005	<.03	0.04	
11/08/98	<.003	0.14	<.02	0.25	0.022	<.001	<.04	33	<.002	<.005	0.046	0.03	0.08	<.1	<.005	11.6	0.01	<.002	2	<.005	2.33	<.02	41	<.03	<.03	3.6	<.01	0.157	<.005	<.005	<.03	0.01	
15/09/98	<.003	0.12	<.02	<.05	0.124	<.001	<.04	40.6	<.002	<.005	<.005	0.017	0.23	1	<.005	16	0.04	0.006	4	<.005	1.1	<.02	15.9	<.03	<.03	3.4	<.01	0.197	0.012	<.005	<.03	0.03	
19/10/98	<.003	0.11	<.02	0.13	0.053	<.001	<.04	44.4	<.002	<.005	0.02	0.014	0.18	<.1	<.005	17.5	0.03	<.002	4	0.012	2.49	<.02	20.7	<.03	<.03	2.7	<.01	0.203	0.031	0.012	<.03	0.04	
17/11/98	<.003	0.14	<.005	<.05	0.206	<.001	<.04	131.8	<.001	<.005	0.086	0.025	0.16	3	<.005	60.3	0.15	0.01	10	0.01	1.82	<.01	60	<.03	<.03	6.6	<.01	0.537	0.012	<.005	<.03	0.04	
31/12/98	<.003	0.07	<.005	0.16	0.077	<.001	<.04	75.7	<.001	<.005	<.005	0.04	0.09	2	0.024	35.5	0.34	<.002	6	0.006	5.1	<.01	37	0.04	<.03	3.4	<.01	0.367	0.01	<.005	<.03	0.02	

JAN 1998 - DEC 1998

Mean	0.003	0.12	0.017	0.1	0.119	0.001	0.04	61.5	0.002	0.005	0.029	0.024	0.14	1	0.009	26.6	0.09	0.004	5	0.008	1.31	0.02	32	0.03	0.03	3.7	0.01	0.285	0.01	0.008	0.03	0.05
Std. Devia	0	0.11	0.005	0.07	0.059	0	0	31.6	0	0.002	0.024	0.012	0.22	1	0.008	15.7	0.1	0.003	2	0.003	1.56	0.01	16.8	0	0	1.1	0	0.133	0.008	0.005	0	0.07
Minimum	0.003	0.05	0.005	0.05	0.022	0.001	0.04	24.8	0.001	0.005	0.005	0.006	0.01	1	0.005	9.3	0.01	0.002	2	0.005	0.04	0.01	8	0.03	0.03	2.4	0.01	0.109	0.005	0.005	0.03	0.01
Maximum	0.003	0.45	0.02	0.25	0.206	0.001	0.04	131.8	0.002	0.013	0.086	0.04	0.75	3	0.024	60.3	0.34	0.01	10	0.015	5.1	0.04	60	0.04	0.03	6.6	0.01	0.537	0.031	0.019	0.03	0.26
Median	0.003	0.09	0.02	0.05	0.131	0.001	0.04	50.2	0.002	0.005	0.025	0.025	0.08	1	0.005	19.8	0.04	0.002	4	0.006	0.87	0.02	37	0.03	0.03	3.4	0.01	0.234	0.006	0.005	0.03	0.03
Num. Valu	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11

Date	AG-D mg/L	AL-D mg/L	AS-D mg/L	B-D mg/L	BA-D mg/L	BE-D mg/L	BI-D mg/L	CA-D mg/L	CD-D mg/L	CO-D mg/L	CR-D mg/L	CU-D mg/L	FE-D mg/L	HG-D mg/L	K-D mg/L	LA-D mg/L	MG-D mg/L	MN-D mg/L	MO-D mg/L	NA-D mg/L	NI-D mg/L	P-D mg/L	PB-D mg/L	S-D mg/L	SB-D mg/L	SE-D mg/L	SI-D mg/L	SN-D mg/L	SR-D mg/L	TI-D mg/L	V-D mg/L	W-D mg/L	ZN-D mg/L
31/12/98	<.003	<.05	<.005	0.06	0.046	<.001	<.04	82.8	<.001	0.007	0.016	0.003	<.01		1	<.005	40.3	0.21	0.006	6	<.005	<.04	<.01	43	<.03	<.03	3.8	<.01	0.422	<.005	<.005	<.03	<.01

JAN 1998 - DEC 1998

Mean	0.003	0.05	0.005	0.06	0.046	0.001	0.04	82.8	0.001	0.007	0.016	0.003	0.01	1	0.005	40.3	0.21	0.006	6	0.005	0.04	0.01	43	0.03	0.03	3.8	0.01	0.422	0.005	0.005	0.03	0.01
Std. Devia	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Minimum	0.003	0.05	0.005	0.06	0.046	0.001	0.04	82.8	0.001	0.007	0.016	0.003	0.01	1	0.005	40.3	0.21	0.006	6	0.005	0.04	0.01	43	0.03	0.03	3.8	0.01	0.422	0.005	0.005	0.03	0.01
Maximum	0.003	0.05	0.005	0.06	0.046	0.001	0.04	82.8	0.001	0.007	0.016	0.003	0.01	1	0.005	40.3	0.21	0.006	6	0.005	0.04	0.01	43	0.03	0.03	3.8	0.01	0.422	0.005	0.005	0.03	0.01
Median	0.003	0.05	0.005	0.06	0.046	0.001	0.04	82.8	0.001	0.007	0.016	0.003	0.01	1	0.005	40.3	0.21	0.006	6	0.005	0.04	0.01	43	0.03	0.03	3.8	0.01	0.422	0.005	0.005	0.03	0.01
Num. Valu	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1

STATION: V15, Sulphide cell sump, Grum Dump

	AG-T	AL-T	AS-T	B-T	BA-T	BE-T	BI-T	CA-T	CD-T	CO-T	CR-T	CU-T	FE-T	HG-T	K-T	LA-T	MG-T	MN-T	MO-T	NA-T	NI-T	P-T	PB-T	S-T	SB-T	SE-T	SI-T	SN-T	SR-T	TI-T	V-T	W-T	ZN-T
Date	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
12/01/98	<.003	0.24	<.02	<.05	0.388	<.001	<.04	109.3	<.002	<.005	<.005	0.012	0.74	2	<.005	38.4	0.02	<.002	5	<.005	<.04	<.02	37	<.03	<.03	3.2	<.01	0.611	0.013	<.005	<.03	0.01	
17/03/98	<.003	3.73	<.02	<.05	0.723	<.001	<.04	140.1	<.002	0.011	0.04	0.049	7.9	2	0.024	55.4	0.14	0.011	9	0.018	0.05	0.16	39	<.03	<.03	8.8	<.01	0.782	0.127	0.02	<.03	0.09	
18/05/98	<.003	5.58	0.03	0.21	0.899	<.001	<.04	132.7	<.002	<.005	<.005	0.069	11.69	3	0.017	51.4	0.19	<.002	9	0.037	0.42	0.19	30	0.09	<.03	11.9	<.01	0.745	0.176	0.017	<.03	0.13	
29/06/98	0.004	0.09	<.02	<.05	0.441	0.001	<.04	127.2	<.002	0.01	<.005	0.018	<.01	3	0.027	47	<.01	0.013	7	0.01	1.37	<.02	12	<.03	<.03	5.2	<.01	0.757	0.022	<.005	<.03	0.01	
14/09/98	<.003	0.11	<.02	<.05	0.483	<.001	<.04	145.2	<.002	<.005	<.005	0.025	0.08	3	<.005	53	0.02	0.005	8	0.01	<.04	0.03	62.9	<.03	<.03	5	<.01	0.867	0.016	0.005	<.03	0.03	
31/12/98	<.003	3.53	<.005	0.21	0.58	<.001	<.04	164.3	<.001	0.007	<.005	0.066	5.05	3	0.055	65.3	0.06	0.006	10	0.011	8.02	<.01	64	0.04	<.03	10.4	<.01	1.008	0.111	<.005	<.03	0.05	

JAN 1998 - DEC 1998

Mean	0.003	2.21	0.019	0.1	0.586	0.001	0.04	136.5	0.002	0.007	0.011	0.04	4.25	3	0.022	51.8	0.07	0.007	8	0.015	1.66	0.07	40.8	0.04	0.03	7.4	0.01	0.795	0.078	0.01	0.03	0.05
Std. Devia	0	2.37	0.008	0.08	0.194	0	0	18.5	0	0.003	0.014	0.025	4.84	1	0.019	8.9	0.07	0.005	2	0.011	3.16	0.08	20	0.02	0	3.4	0	0.133	0.07	0.007	0	0.05
Minimum	0.003	0.09	0.005	0.05	0.388	0.001	0.04	109.3	0.001	0.005	0.005	0.012	0.01	2	0.005	38.4	0.01	0.002	5	0.005	0.04	0.01	12	0.03	0.03	3.2	0.01	0.611	0.013	0.005	0.03	0.01
Maximum	0.004	5.58	0.03	0.21	0.899	0.001	0.04	164.3	0.002	0.011	0.04	0.069	11.69	3	0.055	65.3	0.09	0.013	10	0.037	8.02	0.19	64	0.09	0.03	11.9	0.01	1.008	0.176	0.02	0.03	0.13
Median	0.003	1.88	0.02	0.05	0.531	0.001	0.04	136.4	0.002	0.006	0.005	0.037	2.9	3	0.021	52.2	0.04	0.006	8	0.01	0.23	0.02	38	0.03	0.03	7	0.01	0.77	0.067	0.005	0.03	0.04
Num. Valu	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6

Date	AG-D mg/L	AL-D mg/L	AS-D mg/L	B-D mg/L
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VANGORDA PLATEAU SITE WATER QUALITY LISTING - 1998

STATION: V17A, Runoff from ore transfer pad

	AG-T	AL-T	AS-T	B-T	BA-T	BE-T	BI-T	CA-T	CD-T	CO-T	CR-T	CU-T	FE-T	HG-T	K-T	LA-T	MG-T	MN-T	MO-T	NA-T	NI-T	P-T	PB-T	S-T	SB-T	SE-T	SI-T	SN-T	SR-T	TI-T	V-T	W-T	ZN-T				
Date	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L					
18/05/98	<.003	0.51	0.06	0.18	0.041	<.001	<.04	13.4	<.002	<.005	0.033	0.029	0.83		1	<.005	2.7	0.07	0.004	2	0.006	0.28	<.02	3	<.03	<.03	2.4	<.01	0.059	<.005	<.005	<.03	0.05				
30/06/98	<.003	<.05	<.02	<.05	0.137	<.001	<.04	10.7	<.002	<.005	0.032	0.008	0.12		<1	<.005	1.6	<.01	<.002	2	<.005	2.69	<.02	5	<.03	<.03	5.6	<.01	0.058	0.009	<.005	<.03	<.01				
14/09/98	<.003	<.05	<.02	<.05	0.098	<.001	<.04	17.1	<.002	<.005	<.005	0.014	0.25		<1	<.005	2.5	0.02	<.002	2	<.005	<.04	0.02	2.4	<.03	<.03	5.2	<.01	0.084	0.006	<.005	<.03	0.02				
JAN 1998 - DEC 1998																																					
Mean	0.003	0.2	0.03	0.09	0.092	0.001	0.04	13.7	0.002	0.005	0.023	0.017	0.4		1	0.005	2.3	0.03	0.003	2	0.005	1	0.02	3.5	0.03	0.03	4.4	0.01	0.067	0.007	0.005	0.03	0.03				
Std. Devia	0	0.27	0.02	0.08	0.048	0	0	3.2	0	0	0.016	0.011	0.38		0	0	0.6	0.03	0.001	0	0.001	1.47	0	1.4	0	0	1.7	0	0.015	0.002	0	0	0.02				
Minimum	0.003	0.05	0.02	0.05	0.041	0.001	0.04	10.7	0.002	0.005	0.005	0.008	0.12		1	0.005	1.6	0.01	0.002	2	0.005	0.04	0.02	2.4	0.03	0.03	2.4	0.01	0.058	0.005	0.005	0.03	0.01				
Maximum	0.003	0.51	0.06	0.18	0.137	0.001	0.04	17.1	0.002	0.005	0.033	0.029	0.83		1	0.005	2.7	0.07	0.004	2	0.006	2.69	0.02	5	0.03	0.03	5.6	0.01	0.084	0.009	0.005	0.03	0.05				
Median	0.003	0.05	0.02	0.05	0.098	0.001	0.04	13.4	0.002	0.005	0.032	0.014	0.25		1	0.005	2.5	0.02	0.002	2	0.005	0.28	0.02	3	0.03	0.03	5.2	0.01	0.059	0.006	0.005	0.03	0.02				
Num. Valu	3	3	3	3	3	3	3	3	3	3	3	3	3		3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3					

STATION: V18, Grum Dump, SE Interceptor ditch

	AG-T	AL-T	AS-T	B-T	BA-T	BE-T	BI-T	CA-T	CD-T	CO-T	CR-T	CU-T	FE-T	HG-T	K-T	LA-T	MG-T	MN-T	MO-T	NA-T	NI-T	P-T	PB-T	S-T	SB-T	SE-T	SI-T	SN-T	SR-T	TI-T	V-T	W-T	ZN-T				
Date	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L					
18/05/98	<.003	2.67	<.02	0.24	0.065	<.001	<.04	9.1	<.002	<.005	0.039	0.036	4.59		2	<.005	3	0.07	<.002	2	0.018	<.04	<.02	2	0.06	<.03	5.6	<.01	0.046	0.067	0.009	<.03	0.07				
JAN 1998 - DEC 1998																																					
Mean	0.003	2.67	0.02	0.24	0.065	0.001	0.04	9.1	0.002	0.005	0.039	0.036	4.59		2	0.005	3	0.07	0.002	2	0.018	0.04	0.02	2	0.06	0.03	5.6	0.01	0.046	0.067	0.009	0.03	0.07				
Std. Devia	0	0	0	0	0	0	0	0	0	0	0	0	0		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0					
Minimum	0.003	2.67	0.02	0.24	0.065	0.001	0.04	9.1	0.002	0.005	0.039	0.036	4.59		2	0.005	3	0.07	0.002	2	0.018	0.04	0.02	2	0.06	0.03	5.6	0.01	0.046	0.067	0.009	0.03	0.07				
Maximum	0.003	2.67	0.02	0.24	0.065	0.001	0.04	9.1	0.002	0.005	0.039	0.036	4.59		2	0.005	3	0.07	0.002	2	0.018	0.04	0.02	2	0.06	0.03	5.6	0.01	0.046	0.067	0.009	0.03	0.07				
Median	0.003	2.67	0.02	0.24	0.065	0.001	0.04	9.1	0.002	0.005	0.039	0.036	4.59		2	0.005	3	0.07	0.002	2	0.018	0.04	0.02	2	0.06	0.03	5.6	0.01	0.046	0.067	0.009	0.03	0.07				
Num. Valu	1	1	1	1	1	1	1	1	1	1	1	1	1		1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1					

STATION: V20, Vangorda pit, NE Interceptor ditch

	AG-T	AL-T	AS-T	B-T	BA-T	BE-T	BI-T	CA-T	CD-T	CO-T	CR-T	CU-T	FE-T	HG-T	K-T	LA-T	MG-T	MN-T	MO-T	NA-T	NI-T	P-T	PB-T	S-T	SB-T	SE-T	SI-T	SN-T	SR-T	TI-T	V-T	W-T	ZN-T
Date	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	
18/05/98	<.003	0.3	<.02	0.18	0.04	0.02	<.04	13.1	<.002	<.005	0.047	0.031	0.36		1	0.013	4.2	0.1	<.002	2	0.01	<.04	<.02	25	<.03	<.03	3.2	<.01	0.059	<.005	<.005	<.03	0.4
JAN 1998 - DEC 1998																																	
Mean	0.003	0.3	0.02	0.18	0.04	0.02	0.04	13.1	0.002	0.005	0.047	0.031	0.36		1	0.013	4.2	0.1	0.002	2	0.01	0.04	0.02	25	0.03	0.03	3.2	0.01	0.059	0.005	0.005	0.03	0.4
Std. Devia	0	0	0	0	0	0	0	0	0	0	0	0	0		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Minimum	0.003	0.3	0.02	0.18	0.04	0.02	0.04	13.1	0.002	0.005	0.047	0.031	0.36		1	0.013	4.2	0.1	0.002	2	0.01	0.04	0.02	25	0.03	0.03	3.2	0.01	0.059	0.005	0.005	0.03	0.4
Maximum	0.003	0.3	0.02	0.18	0.04	0.02	0.04	13.1	0.002	0.005	0.047	0.031	0.36		1	0.013	4.2	0.1	0.002	2	0.01	0.04	0.02	25	0.03	0.03	3.2	0.01	0.059	0.005	0.005	0.03	0.4
Median	0.003	0.3	0.02	0.18	0.04	0.02	0.04	13.1	0.002	0.005	0.047	0.031	0.36		1	0.013	4.2	0.1	0.002	2	0.01	0.04	0.02	25	0.03	0.03	3.2	0.01	0.059	0.005	0.005	0.03	0.4
Num. Valu	1	1	1	1	1	1	1	1	1	1	1	1	1		1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	

STATION: V21A, VG Dump Collector Ditch @ LCD

	AG-T	AL-T	AS-T	B-T	BA-T	BE-T	BI-T	CA-T	CD-T	CO-T	CR-T	CU-T	FE-T	HG-T	K-T	LA-T	MG-T	MN-T	MO-T	NA-T	NI-T	P-T	PB-T	S-T	SB-T	SE-T	SI-T	SN-T	SR-T	TI-T	V-T	W-T	ZN-T
Date	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	
18/05/98	<.003	0.31	0.04	0.2	0.06	0.021	<.04	94.7	0.004	0.014	0.023	0.046	0.44		2	<.005	41.7	0.95	<.002	3	0.062	1.23	<.02	145	<.03	<.03	1.9	<.01	0.37	0.006	<.005	<.03	1.79
JAN 1998 - DEC 1998																																	
Mean	0.003	0.31	0.04	0.2	0.06	0.021	0.04	94.7	0.004	0.014	0.023	0.046	0.44		2	0.005	41.7	0.95	0.002	3	0.062	1.23	0.02	145	0.03	0.03	1.9	0.01	0.37	0.006	0.005	0.03	1.79
Std. Devia	0	0	0	0	0	0	0	0	0	0	0	0	0		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Minimum	0.003	0.31	0.04	0.2	0.06	0.021	0.04	94.7	0.004	0.014	0.023	0.046	0.44		2	0.005	41.7	0.95	0.002	3	0.062	1.23	0.02	145	0.03	0.03	1.9	0.01	0.37	0.006	0.005	0.03	1.79
Maximum	0.003	0.31	0.04	0.2	0.06	0.021	0.04	94.7	0.004	0.014	0.023	0.046	0.44		2	0.005	41.7	0.95	0.002	3	0.062	1.23	0.02	145	0.03	0.03	1.9	0.01	0.37	0.006	0.005	0.03	1.79
Median	0.003	0.31	0.04	0.2	0.06	0.021	0.04	94.7	0.004	0.014	0.023	0.046	0.44		2	0.005	41.7	0.95	0.002	3	0.062	1.23	0.02	145	0.03	0.03	1.9	0.01	0.37	0.006	0.005	0.03	1.79
Num. Valu	1	1	1	1	1	1	1	1	1	1	1	1	1		1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	

STATION: V22, Vangorda pit water

STATION: V23, Grum Pit WaterSTATION: V25BSP, Below Sheep Pond at the weir[illegible]

VANGORDA PLATEAU SITE WATER QUALITY LISTING - 1998

STATION: V27, Vangorda Creek, just upstr. of Shrimp

	AG-T	AL-T	AS-T	B-T	BA-T	BE-T	BI-T	CA-T	CD-T	CO-T	CR-T	CU-T	FE-T	HG-T	K-T	LA-T	MG-T	MN-T	MO-T	NA-T	NI-T	P-T	PB-T	S-T	SB-T	SE-T	SI-T	SN-T	SR-T	TI-T	V-T	W-T	ZN-T				
Date	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L				
29/05/98	<.003	0.2	<.02	<.05	0.104	0.002	<.04	6.3	<.002	0.008	0.033	0.01	0.53		<1	0.006	2	0.02	<.002	<1	<.005	0.3	<.02	15	<.03	<.03	2.6	<.01	0.032	0.012	0.008	<.03	0.09				
29/06/98	<.003	<.05	<.02	<.05	0.139	<.001	<.04	12.8	<.002	<.005	<.005	0.006	0.01		<1	<.005	2.9	<.01	<.002	2	<.005	1.66	<.02	14	<.03	<.03	4	<.01	0.076	0.007	<.005	<.03	0.05				
14/09/98	<.003	0.13	<.02	<.05	0.089	<.001	<.04	16.4	<.002	0.006	0.027	0.021	0.08		<1	<.005	3.6	<.01	0.005	3	<.005	<.04	<.02	6.1	<.03	<.03	4.5	<.01	0.094	0.011	<.005	<.03	0.04				
JAN 1998 - DEC 1998																																					
Mean	0.003	0.13	0.02	0.05	0.111	0.001	0.04	11.8	0.002	0.006	0.022	0.012	0.21		1	0.005	2.8	0.01	0.003	2	0.005	0.67	0.02	11.7	0.03	0.03	3.7	0.01	0.067	0.01	0.006	0.03	0.06				
Std. Devia	0	0.08	0	0	0.026	0.001	0	5.1	0	0.002	0.015	0.008	0.28		0	0.001	0.8	0.01	0.002	1	0	0.87	0	4.9	0	0	1	0	0.032	0.003	0.002	0	0.03				
Minimum	0.003	0.05	0.02	0.05	0.089	0.001	0.04	6.3	0.002	0.005	0.005	0.006	0.01		1	0.005	2	0.01	0.002	1	0.005	0.04	0.02	6.1	0.03	0.03	2.6	0.01	0.032	0.007	0.005	0.03	0.04				
Maximum	0.003	0.2	0.02	0.05	0.139	0.002	0.04	16.4	0.002	0.008	0.033	0.021	0.53		1	0.006	3.6	0.02	0.005	3	0.005	1.66	0.02	15	0.03	0.03	4.5	0.01	0.094	0.012	0.008	0.03	0.09				
Median	0.003	0.13	0.02	0.05	0.104	0.001	0.04	12.8	0.002	0.006	0.027	0.01	0.08		1	0.005	2.9	0.01	0.002	2	0.005	0.3	0.02	14	0.03	0.03	4	0.01	0.076	0.011	0.005	0.03	0.05				
Num. Valu	3	3	3	3	3	3	3	3	3	3	3	3	3		3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3					

STATION: V29, Vangorda Dump drain #2

	AG-D	AL-D	AS-D	B-D	BA-D	BE-D	BI-D	CA-D	CD-D	CO-D	CR-D	CU-D	FE-D	HG-D	K-D	LA-D	MG-D	MN-D	MO-D	NA-D	NI-D	P-D	PB-D	S-D	SB-D	SE-D	SI-D	SN-D	SR-D	TI-D	V-D	W-D	ZN-D				
Date	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L					
18/05/98	<.003	0.21	0.09	<.05	0.122	0.002	<.04	268.2	0.086	0.328	<.005	0.033	0.06		7	0.038	133.2	12.73	0.072	8	1.062	4.27	0.14	412	0.13	<.03	4	<.01	0.973	0.02	<.005	<.03	40.64				
JAN 1998 - DEC 1998																																					
Mean	0.003	0.21	0.09	0.05	0.122	0.002	0.04	268.2	0.086	0.328	0.005	0.033	0.06		7	0.038	133.2	12.73	0.072	8	1.062	4.27	0.14	412	0.13	0.03	4	0.01	0.973	0.02	0.005	0.03	40.64				
Std. Devia	0	0	0	0	0	0	0	0	0	0	0	0	0		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0					
Minimum	0.003	0.21	0.09	0.05	0.122	0.002	0.04	268.2	0.086	0.328	0.005	0.033	0.06		7	0.038	133.2	12.73	0.072	8	1.062	4.27	0.14	412	0.13	0.03	4	0.01	0.973	0.02	0.005	0.03	40.64				
Maximum	0.003	0.21	0.09	0.05	0.122	0.002	0.04	268.2	0.086	0.328	0.005	0.033	0.06		7	0.038	133.2	12.73	0.072	8	1.062	4.27	0.14	412	0.13	0.03	4	0.01	0.973	0.02	0.005	0.03	40.64				
Median	0.003	0.21	0.09	0.05	0.122	0.002	0.04	268.2	0.086	0.328	0.005	0.033	0.06		7	0.038	133.2	12.73	0.072	8	1.062	4.27	0.14	412	0.13	0.03	4	0.01	0.973	0.02	0.005	0.03	40.64				
Num. Valu	1	1	1	1	1	1	1	1	1	1	1	1	1		1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1					

STATION: V30, Vangorda Dump drain #3

	AG-D	AL-D	AS-D	B-D	BA-D	BE-D	BI-D	CA-D	CD-D	CO-D	CR-D	CU-D	FE-D	HG-D	K-D	LA-D	MG-D	MN-D	MO-D	NA-D	NI-D	P-D	PB-D	S-D	SB-D	SE-D	SH-D	SN-D	SR-D	TI-D	V-D	W-D	ZN-D
Date	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	
18/05/98	<.003	0.41	0.22	<.05	0.066	0.003	<.04	410.2	0.312	2.97	<.005	0.038	17.44		12	<.005	342.6	105.9	0.432	12	4.984	40.05	1.47	878	1.09	<.03	5.9	<.01	1.592	0.021	<.005	<.03	314.5
29/06/98	0.019	<.05	0.86	<.05	0.421	0.007	<.04	450.9	0.186	2.659	0.692	0.054	10.2		8	0.051	448.5	87.13	0.357	25	4.783	49.99	1.56	919	0.21	<.03	6.3	<.01	1.98	0.093	0.054	<.03	268.11
14/09/98	<.003	<.05	<.02	<.05	0.019	0.005	<.04	372.2	0.184	2.189	0.549	0.049	1.67		12	<.005	365.2	77.21	0.237	20	3.885	31.89	0.99	879.1	0.37	<.03	4.8	<.01	1.618	<.005	<.005	<.03	187
JAN 1998 - DEC 1998																																	
Mean	0.008	0.17	0.37	0.05	0.169	0.005	0.04	411.1	0.227	2.606	0.415	0.047	9.77		11	0.02	385.4	90.08	0.342	19	4.551	40.64	1.34	892	0.56	0.03	5.7	0.01	1.73	0.04	0.021	0.03	256.54
Std. Devia	0.009	0.21	0.44	0	0.22	0.002	0	39.4	0.073	0.393	0.362	0.008	7.89		2	0.027	55.8	14.57	0.098	7	0.585	9.06	0.31	23.4	0.47	0	0.8	0	0.217	0.047	0.028	0	64.53
Minimum	0.003	0.05	0.02	0.05	0.019	0.003	0.04	372.2	0.184	2.189	0.005	0.038	1.67		8	0.005	342.6	77.21	0.237	12	3.885	31.89	0.99	878	0.21	0.03	4.8	0.01	1.592	0.005	0.005	0.03	187
Maximum	0.019	0.41	0.86	0.05	0.421	0.007	0.04	450.9	0.312	2.97	0.692	0.054	17.44		12	0.051	448.5	105.9	0.432	25	4.984	49.99	1.56	919	1.09	0.03	6.3	0.01	1.98	0.093	0.054	0.03	314.5
Median	0.003	0.05	0.22	0.05	0.066	0.005	0.04	410.2	0.186	2.659	0.549	0.049	10.2		12	0.005	365.2	87.13	0.357	20	4.783	40.05	1.47	879.1	0.37	0.03	5.9	0.01	1.618	0.021	0.005	0.03	268.11
Num. Valu	3	3	3	3	3	3	3	3	3	3	3	3	3		3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	

STATION: V31, Vangorda Dump drain #4

	AG-D	AL-D	AS-D	B-D	BA-D	BE-D	BI-D	CA-D	CD-D	CO-D	CR-D	CU-D	FE-D	HG-D	K-D	LA-D	MG-D	MN-D	MO-D	NA-D	NI-D	P-D	PB-D	S-D	SB-D	SE-D	SI-D	SN-D	SR-D	TI-D	V-D	W-D	ZN-D
Date	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	
18/05/98	<.003	0.55	0.13	<.05	0.079	0.003	<.04	496.9	0.072	1.34	<.005	0.043	0.29		11	0.026	335.4	50.46	0.103	15	1.608	5.23	0.36	724	0.24	<.03	6.2	<.01	1.503	0.033	<.005	<.03	75.83
JAN 1998 - DEC 1998																																	
Mean	0.003	0.55	0.13	0.05	0.079	0.003	0.04	496.9	0.072	1.34	0.005	0.043	0.29		11	0.026	335.4	50.46	0.103	15	1.608	5.23	0.36	724	0.24	0.03	6.2	0.01	1.503	0.033	0.005	0.03	75.83
Std. Devia	0	0	0	0	0	0	0	0	0	0	0	0	0		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Minimum	0.003	0.55	0.13	0.05	0.079	0.003	0.04	496.9	0.072	1.34	0.005	0.043	0.29		11	0.026	335.4	50.46	0.103	15	1.608	5.23	0.36	724	0.24	0.03	6.2	0.01	1.503	0.033	0.005	0.03	75.83
Maximum	0.003	0.55	0.13	0.05	0.079	0.003	0.04	496.9	0.072	1.34	0.005	0.043	0.29		11	0.026	335.4	50.46	0.103	15	1.608	5.23	0.36	724	0.24	0.03	6.2	0.01	1.503	0.033	0.005	0.03	75.83
Median	0.003	0.55	0.13	0.05	0.079	0.003	0.04	496.9	0.072	1.34	0.005	0.043	0.29		11	0.026	335.4	50.46	0.103	15	1.608	5.23	0.36	724	0.24	0.03	6.2	0.01	1.503	0.033	0.005	0.03	75.83
Num. Valu	1	1	1	1	1	1	1	1	1	1	1	1	1		1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	

VANGORDA PLATEAU SITE WATER QUALITY LISTING - 1998

STATION: V32, Vangorda Dump drain #5

	AG-D	AL-D	AS-D	B-D	BA-D	BE-D	BI-D	CA-D	CD-D	CO-D	CR-D	CU-D	FE-D	HG-D	K-D	LA-D	MG-D	MN-D	MO-D	NA-D	NI-D	P-D	PB-D	S-D	SB-D	SE-D	SI-D	SN-D	SR-D	TI-D	V-D	W-D	ZN-D				
Date	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L					
18/05/98	0.059	3.2	0.59	<0.5	0.101	0.005	<0.4	335.4	1.59	6.82	<0.005	0.092	9.15		15	<0.005	584.2	316.6	0.98	12	4.182	82.5	3.65	>1000	2.51	<0.3	9.7	<0.1	0.607	0.081	<0.005	<0.3	706.1				
29/06/98	0.137	4.56	2.11	0.07	0.664	0.012	1.26	447	3.86	12.419	0.87	0.123	55.98		17	0.215	>1000	665.74	2.479	23	8.551	292	11.82	1320	6.18	<0.3	17	<0.1	1.012	0.112	0.184	<0.3	1800.2				
14/09/98	0.174	7.6	1.44	<0.5	0.294	0.001	<0.4	407	3.953	13.682	0.816	0.147	38.17		18	0.336	>1000	940.35	2.974	22	10.12	240.1	11.22	3649	7.67	<0.3	16.5	<0.1	0.907	0.018	<0.005	<0.3	2179.8				
JAN 1998 - DEC 1998																																					
Mean	0.123	5.12	1.38	0.06	0.353	0.006	0.45	396.5	3.134	10.974	0.564	0.121	34.43		17	0.185	861.4	640.9	2.144	19	7.616	204.8	8.9	1990	5.45	0.03	14.4	0.01	0.842	0.07	0.065	0.03	1562				
Std. Devia	0.059	2.25	0.76	0.01	0.286	0.006	0.7	56.5	1.338	3.652	0.485	0.028	23.64		2	0.167	240.1	312.62	1.038	6	3.075	109.1	4.55	1446	2.66	0	4.1	0	0.21	0.048	0.103	0	765.17				
Minimum	0.059	3.2	0.59	0.05	0.101	0.001	0.04	335.4	1.59	6.82	0.005	0.092	9.15		15	0.005	584.2	316.6	0.98	12	4.182	82.5	3.65	1000	2.51	0.03	9.7	0.01	0.607	0.018	0.005	0.03	706.1				
Maximum	0.174	7.6	2.11	0.07	0.664	0.012	1.26	447	3.953	13.682	0.87	0.147	55.98		18	0.336	1000	940.35	2.974	23	10.12	292	11.82	3649	7.67	0.03	17	0.01	1.012	0.112	0.184	0.03	2179.8				
Median	0.137	4.56	1.44	0.05	0.294	0.005	0.04	407	3.86	12.419	0.816	0.123	38.17		17	0.215	1000	665.74	2.479	22	8.551	240.1	11.22	1320	6.18	0.03	16.5	0.01	0.907	0.081	0.005	0.03	1800.2				
Num. Valu	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3					

STATION: V33, Vangorda Dump drain #6

	AG-D	AL-D	AS-D	B-D	BA-D	BE-D	BI-D	CA-D	CD-D	CO-D	CR-D	CU-D	FE-D	HG-D	K-D	LA-D	MG-D	MN-D	MO-D	NA-D	NI-D	P-D	PB-D	S-D	SB-D	SE-D	SI-D	SN-D	SR-D	TI-D	V-D	W-D	ZN-D
Date	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
18/05/98	<.003	0.13	<.02	<.05	0.079	0.001	<.04	86.6	0.041	0.447	<.005	0.011	0.09		2	<.005	65.2	26.87	0.056	3	0.265	5.06	0.21	303	0.12	<.03	0.5	<.01	0.303	<.005	<.005	<.03	32.78
15/09/98	0.004	0.14	<.02	<.05	0.046	0.005	<.04	330.3	0.328	4.424	0.31	0.064	1.06		7	<.005	428	250.06	0.49	12	2.662	63.47	1.85	1015	1.09	<.03	3.1	<.01	1.295	<.005	<.005	<.03	331.96
JAN 1998 - DEC 1998																																	
Mean	0.004	0.13	0.02	0.05	0.063	0.003	0.04	208.4	0.185	2.435	0.158	0.038	0.57		4	0.005	246.6	138.46	0.273	8	1.463	34.27	1.03	658.9	0.61	0.03	1.8	0.01	0.799	0.005	0.005	0.03	182.37
Std. Devia	0.001	0.01	0	0	0.023	0.003	0	172.3	0.203	2.812	0.216	0.037	0.69		4	0	256.5	157.82	0.307	6	1.695	41.3	1.16	503.3	0.69	0	1.8	0	0.701	0	0	0	211.55
Minimum	0.003	0.13	0.02	0.05	0.046	0.001	0.04	86.6	0.041	0.447	0.005	0.011	0.09		2	0.005	65.2	26.87	0.056	3	0.265	5.06	0.21	303	0.12	0.03	0.5	0.01	0.303	0.005	0.005	0.03	32.78
Maximum	0.004	0.14	0.02	0.05	0.079	0.005	0.04	330.3	0.328	4.424	0.31	0.064	1.06		7	0.005	428	250.06	0.49	12	2.662	63.47	1.85	1015	1.09	0.03	3.1	0.01	1.295	0.005	0.005	0.03	331.96
Median	0.004	0.13	0.02	0.05	0.063	0.003	0.04	208.4	0.185	2.435	0.158	0.038	0.57		4	0.005	246.6	138.46	0.273	8	1.463	34.27	1.03	658.9	0.61	0.03	1.8	0.01	0.799	0.005	0.005	0.03	182.37
Num. Valu	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	

STATION: V34, groundwater well GW94-01

	AG-D	AL-D	AS-D	B-D	BA-D	BE-D	BI-D	CA-D	CD-D	CO-D	CR-D	CU-D	FE-D	HG-D	K-D	LA-D	MG-D	MN-D	MO-D	NA-D	NI-D	P-D	PB-D	S-D	SB-D	SE-D	SI-D	SN-D	SR-D	TI-D	V-D	W-D	ZN-D
Date	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	
31/05/98	<.003	<.05	0.04	<.05	0.023	0.002	<.04	40.4	<.002	<.005	<.005	0.005	0.17		5	<.005	70.6	0.04	0.007	5	<.005	<.04	<.02	10	<.03	<.03	5.1	<.01	0.438	0.006	0.015	<.03	0.01
14/09/98	<.003	<.05	0.03	<.05	0.022	<.001	<.04	56.9	<.002	0.009	0.019	0.007	<.01		5	<.005	71.6	0.26	0.009	5	<.005	<.04	0.04	11.3	<.03	<.03	3.8	<.01	0.606	<.005	0.005	<.03	0.16
31/12/98	<.003	<.05	<.005	0.08	0.028	<.001	<.04	59.3	<.001	<.005	<.005	0.003	0.03	<.1	5	0.012	78.8	0.06	0.01	6	<.005	<.04	<.01	9	<.03	<.03	4.4	<.01	0.646	<.005	<.005	<.03	<.01
JAN 1998 - DEC 1998																																	
Mean	0.003	0.05	0.025	0.06	0.024	0.001	0.04	52.2	0.002	0.006	0.01	0.005	0.07	0.1	5	0.007	73.7	0.12	0.009	5	0.005	0.04	0.02	10.1	0.03	0.03	4.4	0.01	0.563	0.005	0.008	0.03	0.06
Std. Devia	0	0	0.018	0.02	0.003	0.001	0	10.3	0.001	0.002	0.008	0.002	0.09	0	0	0.004	4.5	0.12	0.002	1	0	0	0.02	1.2	0	0	0.7	0	0.11	0.001	0.006	0	0.09
Minimum	0.003	0.05	0.005	0.05	0.022	0.001	0.04	40.4	0.001	0.005	0.005	0.003	0.01	0.1	5	0.005	70.6	0.04	0.007	5	0.005	0.04	0.01	9	0.03	0.03	3.8	0.01	0.438	0.005	0.005	0.03	0.01
Maximum	0.003	0.05	0.04	0.08	0.028	0.002	0.04	59.3	0.002	0.009	0.019	0.007	0.17	0.1	5	0.012	78.8	0.26	0.01	6	0.005	0.04	0.04	11.3	0.03	0.03	5.1	0.01	0.646	0.006	0.015	0.03	0.16
Median	0.003	0.05	0.03	0.05	0.023	0.001	0.04	56.9	0.002	0.005	0.005	0.005	0.03	0.1	5	0.005	71.6	0.06	0.009	5	0.005	0.04	0.02	10	0.03	0.03	4.4	0.01	0.606	0.005	0.005	0.03	0.01
Num. Valu	3	3	3	3	3	3	3	3	3	3	3	3	3	1	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	

VANGORDA PLATEAU SITE WATER QUALITY LISTING - 1998

STATION: V35, groundwater well GW94-02

	AG-D	AL-D	AS-D	B-D	BA-D	BE-D	BI-D	CA-D	CD-D	CO-D	CR-D	CU-D	FE-D	HG-D	K-D	LA-D	MG-D	MN-D	MO-D	NA-D	NI-D	P-D	PB-D	S-D	SB-D	SE-D	SI-D	SN-D	SR-D	TI-D	V-D	W-D	ZN-D
Date	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L
31/05/98	<.003	0.13	<.02	<.05	0.065	0.003	<.04	158.2	<.002	0.007	<.005	0.014	0.19		4	0.023	125.1	0.15	0.005	8	<.005	0.26	<.02	49	<.03	<.03	5.3	<.01	0.838	0.014	<.005	<.03	0.01
14/09/98	0.003	0.11	0.09	<.05	0.034	0.002	<.04	215.5	<.002	0.008	<.005	0.019	<.01		4	<.005	148.9	0.34	0.019	9	0.016	0.76	<.02	216.1	<.03	<.03	4.7	<.01	1.097	0.01	<.005	<.03	0.11
31/12/98	<.003	0.07	<.005	<.05	0.021	<.001	<.04	243.2	<.001	<.005	<.005	0.014	0.21	<.1	4	<.005	175.6	0.28	<.002	10	<.005	7.52	<.01	268	<.03	<.03	5	<.01	1.215	0.013	<.005	<.03	<.01
JAN 1998 - DEC 1998																																	
Mean	0.003	0.1	0.038	0.05	0.04	0.002	0.04	205.6	0.002	0.007	0.005	0.016	0.14	0.1	4	0.011	149.9	0.26	0.009	9	0.009	2.85	0.02	177.7	0.03	0.03	5	0.01	1.05	0.012	0.005	0.03	0.04
Std. Devia	0	0.03	0.045	0	0.023	0.001	0	43.4	0.001	0.002	0	0.003	0.11	0	0	0.01	25.3	0.1	0.009	1	0.006	4.05	0.01	114.4	0	0	0.3	0	0.193	0.002	0	0	0.06
Minimum	0.003	0.07	0.005	0.05	0.021	0.001	0.04	158.2	0.001	0.005	0.005	0.014	0.01	0.1	4	0.005	125.1	0.15	0.002	8	0.005	0.26	0.01	49	0.03	0.03	4.7	0.01	0.838	0.01	0.005	0.03	0.01
Maximum	0.003	0.13	0.09	0.05	0.065	0.003	0.04	243.2	0.002	0.008	0.005	0.019	0.21	0.1	4	0.023	175.6	0.34	0.019	10	0.016	7.52	0.02	268	0.03	0.03	5.3	0.01	1.215	0.014	0.005	0.03	0.11
Median	0.003	0.11	0.02	0.05	0.034	0.002	0.04	215.5	0.002	0.007	0.005	0.014	0.19	0.1	4	0.005	148.9	0.28	0.005	9	0.005	0.76	0.02	216.1	0.03	0.03	5	0.01	1.097	0.013	0.005	0.03	0.01
Num. Valu	3	3	3	3	3	3	3	3	3	3	3	3	3	1	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	

STATION: V36, groundwater well GW94-03

	AG-D	AL-D	AS-D	B-D	BA-D	BE-D	BI-D	CA-D	CD-D	CO-D	CR-D	CU-D	FE-D	HG-D	K-D	LA-D	MG-D	MN-D	MO-D	NA-D	NI-D	P-D	PB-D	S-D	SB-D	SE-D	SI-D	SN-D	SR-D	TI-D	V-D	W-D	ZN-D
Date	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	
31/05/98	<.003	0.07	0.09	<.05	0.043	0.002	<.04	92	<.002	0.011	<.005	0.011	0.21		6	0.06	87.9	0.08	0.007	10	<.005	0.13	<.02	117	<.03	<.03	6.6	<.01	0.523	0.01	<.005	<.03	0.03
14/09/98	<.003	<.05	0.05	<.05	0.021	<.001	<.04	106.1	<.002	<.005	0.022	0.012	0.02		5	0.006	84.5	0.09	0.012	10	<.005	<.04	<.02	81.7	<.03	<.03	5.6	<.01	0.595	<.005	<.005	<.03	0.06
31/12/98	<.003	<.05	0.02	0.14	0.009	<.001	<.04	116	<.001	<.005	<.005	0.01	0.07	<.1	5	<.005	96.4	0.08	0.006	11	<.005	<.04	<.01	93	0.04	<.03	6.2	<.01	0.656	<.005	<.005	<.03	<.01
JAN 1998 - DEC 1998																																	
Mean	0.003	0.06	0.053	0.08	0.024	0.001	0.04	104.7	0.002	0.007	0.011	0.011	0.1	0.1	5	0.024	89.6	0.08	0.008	10	0.005	0.07	0.02	97.2	0.03	0.03	6.1	0.01	0.591	0.007	0.005	0.03	0.03
Std. Devia	0	0.01	0.035	0.05	0.017	0.001	0	12.1	0.001	0.003	0.01	0.001	0.1	0	1	0.031	6.1	0.01	0.003	1	0	0.05	0.01	18	0.01	0	0.5	0	0.067	0.003	0	0	0.03
Minimum	0.003	0.05	0.02	0.05	0.009	0.001	0.04	92	0.001	0.005	0.005	0.01	0.02	0.1	5	0.005	84.5	0.08	0.006	10	0.005	0.04	0.01	81.7	0.03	0.03	5.6	0.01	0.523	0.005	0.005	0.03	0.01
Maximum	0.003	0.07	0.09	0.14	0.043	0.002	0.04	116	0.002	0.011	0.022	0.012	0.21	0.1	6	0.06	96.4	0.09	0.012	11	0.005	0.13	0.02	117	0.04	0.03	6.6	0.01	0.656	0.01	0.005	0.03	0.06
Median	0.003	0.05	0.05	0.05	0.021	0.001	0.04	106.1	0.002	0.005	0.005	0.011	0.07	0.1	5	0.006	87.9	0.08	0.007	10	0.005	0.04	0.02	93	0.03	0.03	6.2	0.01	0.595	0.005	0.005	0.03	0.03
Num. Valu	3	3	3	3	3	3	3	3	3	3	3	3	3	1	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	

STATION: V37, groundwater well GW94-04

	AG-D	AL-D	AS-D	B-D	BA-D	BE-D	BI-D	CA-D	CD-D	CO-D	CR-D	CU-D	FE-D	HG-D	K-D	LA-D	MG-D	MN-D	MO-D	NA-D	NI-D	P-D	PB-D	S-D	SB-D	SE-D	SI-D	SN-D	SR-D	TI-D	V-D	W-D	ZN-D	
Date	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L		
31/05/98	<.003	<.05	<.02	<.05	0.087	0.002	<.04	45.7	<.002	<.005	<.005	0.005	0.18		9	0.037	67.8	0.04	0.028	24	<.005	<.04	<.02	18	<.03	<.03	3.6	<.01	0.458	0.007	<.005	<.03	<.01	
14/09/98	<.003	<.05	0.04	<.05	0.068	<.001	<.04	51.8	<.002	0.012	<.005	0.008	<.01		8	<.005	64.6	0.09	0.034	23	0.007	<.04	<.02	21.6	<.03	<.03	1.8	<.01	0.551	<.005	<.005	<.03	0.03	
31/12/98	<.003	<.05	<.005	0.11	0.057	<.001	<.04	53.3	<.001	<.005	<.005	0.003	0.03	<.1	9	<.005	70.8	0.06	0.027	24	<.005	1.69	<.01	25	0.05	<.03	2	<.01	0.532	<.005	<.005	<.03	<.01	
JAN 1998 - DEC 1998																																		
Mean	0.003	0.003	0.05	0.022	0.07	0.071	0.001	0.04	50.3	0.002	0.007	0.005	0.005	0.07	0.1	9	0.016	67.7	0.06	0.03	24	0.005	0.59	0.02	21.5	0.04	0.03	2.5	0.01	0.514	0.006	0.005	0.03	0.02
Std. Devia	0	0	0.018	0.03	0.015	0.001	0	4	0.001	0.004	0	0.003	0.09	0	1	0.018	3.1	0.03	0.004	1	0.001	0.95	0.01	3.5	0.01	0	1	0	0.049	0.001	0	0	0.01	
Minimum	0.003	0.05	0.005	0.05	0.057	0.001	0.04	45.7	0.001	0.005	0.005	0.003	0.01	0.1	8	0.005	64.6	0.04	0.027	23	0.005	0.04	0.01	18	0.03	0.03	1.8	0.01	0.458	0.005	0.005	0.03	0.01	
Maximum	0.003	0.05	0.04	0.11	0.087	0.002	0.04	53.3	0.002	0.012	0.005	0.008	0.18	0.1	9	0.037	70.8	0.09	0.034	24	0.007	1.69	0.02	25	0.05	0.03	3.6	0.01	0.551	0.007	0.005	0.03	0.03	
Median	0.003	0.05	0.02	0.05	0.068	0.001	0.04	51.8	0.002	0.005	0.005	0.005	0.03	0.1	9	0.005	67.8	0.06	0.028	24	0.005	0.04	0.02	21.6	0.03	0.03	2	0.01	0.532	0.005	0.005	0.03	0.01	
Num. Valu	3	3	3	3	3	3	3	3	3	3	3	3	3	1	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3		

VANGORDA PLATEAU SITE WATER QUALITY LISTING - 1998

STATION: V39, Vangorda till berm, P-94-01A

	AG-D	AL-D	AS-D	B-D	BA-D	BE-D	BI-D	CA-D	CD-D	CO-D	CR-D	CU-D	FE-D	HG-D	K-D	LA-D	MG-D	MN-D	MO-D	NA-D	NI-D	P-D	PB-D	S-D	SB-D	SE-D	SI-D	SN-D	SR-D	Ti-D	V-D	W-D	ZN-D
Date	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	
31/05/98	< 003	<.05	0.03	<.05	0.1	0.002	< 04	70.8	<.002	<.005	<.005	0.009	0.19		7	0.026	48	0.06	0.007	37	<.005	0.33	<.02	39	<.03	<.03	5.1	<.01	0.455	0.009	<.005	<.03	0.01
15/09/98	< 003	0.07	<.02	<.05	0.088	<.001	< 04	85.4	<.002	0.005	<.005	0.011	<.01		6	0.019	47.2	0.04	0.017	32	0.008	<.04	<.02	30.4	<.03	<.03	4.1	<.01	0.599	<.005	<.005	<.03	0.02
JAN 1998 - DEC 1998																																	
Mean	0.003	0.06	0.02	0.05	0.094	0.002	0.04	78.1	0.002	0.005	0.005	0.01	0.1		6	0.022	47.6	0.05	0.012	34	0.007	0.19	0.02	34.7	0.03	0.03	4.6	0.01	0.527	0.007	0.005	0.03	0.01
Std. Devia	0	0.01	0.01	0	0.008	0.001	0	10.3	0	0	0	0.001	0.13		1	0.005	0.6	0.01	0.007	4	0.002	0.21	0	6.1	0	0	0.7	0	0.102	0.003	0	0	0.01
Minimum	0.003	0.05	0.02	0.05	0.088	0.001	0.04	70.8	0.002	0.005	0.005	0.009	0.01		6	0.019	47.2	0.04	0.007	32	0.005	0.04	0.02	30.4	0.03	0.03	4.1	0.01	0.455	0.005	0.005	0.03	0.01
Maximum	0.003	0.07	0.03	0.05	0.1	0.002	0.04	85.4	0.002	0.005	0.005	0.011	0.19		7	0.026	48	0.06	0.017	37	0.008	0.33	0.02	39	0.03	0.03	5.1	0.01	0.599	0.009	0.005	0.03	0.02
Median	0.003	0.06	0.02	0.05	0.094	0.002	0.04	78.1	0.002	0.005	0.005	0.01	0.1		6	0.022	47.6	0.05	0.012	34	0.007	0.19	0.02	34.7	0.03	0.03	4.6	0.01	0.527	0.007	0.005	0.03	0.01
Num. Valu	2	2	2	2	2	2	2	2	2	2	2	2	2		2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	

STATION: V40, Vangorda till berm, P-94-01B

	AG-D	AL-D	AS-D	B-D	BA-D	BE-D	BI-D	CA-D	CD-D	CO-D	CR-D	CU-D	FE-D	HG-D	K-D	LA-D	MG-D	MN-D	MO-D	NA-D	NI-D	P-D	PB-D	S-D	SB-D	SE-D	SI-D	SN-D	SR-D	Ti-D	V-D	W-D	ZN-D				
Date	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L					
31/05/98	< 003	0.11	0.02	< 05	0.116	0.003	< 04	144.9	< 002	0.012	< 005	0.014	0.2		4	0.048	72.2	0.05	0.006	9	0.006	< 04	< 02	89	< 03	< 03	6.1	< 01	0.457	0.014	< 005	< 03	< 01				
JAN 1998 - DEC 1998																																					
Mean	0.003	0.11	0.02	0.05	0.116	0.003	0.04	144.9	0.002	0.012	0.005	0.014	0.2		4	0.048	72.2	0.05	0.006	9	0.006	0.04	0.02	89	0.03	0.03	6.1	0.01	0.457	0.014	0.005	0.03	0.01				
Std. Devia	0	0	0	0	0	0	0	0	0	0	0	0	0		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0					
Minimum	0.003	0.11	0.02	0.05	0.116	0.003	0.04	144.9	0.002	0.012	0.005	0.014	0.2		4	0.048	72.2	0.05	0.006	9	0.006	0.04	0.02	89	0.03	0.03	6.1	0.01	0.457	0.014	0.005	0.03	0.01				
Maximum	0.003	0.11	0.02	0.05	0.116	0.003	0.04	144.9	0.002	0.012	0.005	0.014	0.2		4	0.048	72.2	0.05	0.006	9	0.006	0.04	0.02	89	0.03	0.03	6.1	0.01	0.457	0.014	0.005	0.03	0.01				
Median	0.003	0.11	0.02	0.05	0.116	0.003	0.04	144.9	0.002	0.012	0.005	0.014	0.2		4	0.048	72.2	0.05	0.006	9	0.006	0.04	0.02	89	0.03	0.03	6.1	0.01	0.457	0.014	0.005	0.03	0.01				
Num. Valu	1	1	1	1	1	1	1	1	1	1	1	1	1		1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1					

STATION: V41, Vangorda till berm, P-94-02A

	AG-D	AL-D	AS-D	B-D	BA-D	BE-D	BI-D	CA-D	CD-D	CO-D	CR-D	CU-D	FE-D	HG-D	K-D	LA-D	MG-D	MN-D	MO-D	NA-D	NI-D	P-D	PB-D	S-D	SB-D	SE-D	SI-D	SN-D	SR-D	Ti-D	V-D	W-D	ZN-D
Date	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	
31/05/98	< 003	< 05	< 02	< 05	0.068	0.002	< 04	31.4	< 002	0.007	< 005	0.006	0.23		5	0.032	55.5	0.02	< 002	6	0.011	< 04	< 02	14	< 03	< 03	5.8	< 01	0.448	0.005	< 005	< 03	0.01
15/09/98	< 003	< 05	< 02	< 05	0.133	< 001	< 04	80.4	< 002	0.01	< 005	0.008	< 01		4	0.011	57.9	0.47	0.004	7	< 005	1.02	< 02	13.3	< 03	< 03	4.8	< 01	0.723	< 005	< 005	< 03	0.02
JAN 1998 - DEC 1998																																	
Mean	0.003	0.05	0.02	0.05	0.101	0.002	0.04	55.9	0.002	0.008	0.005	0.007	0.12		4	0.022	56.7	0.24	0.003	6	0.008	0.53	0.02	13.7	0.03	0.03	5.3	0.01	0.586	0.005	0.005	0.03	0.01
Std. Devia	0	0	0	0	0.046	0.001	0	34.6	0	0.002	0	0.001	0.16		1	0.015	1.7	0.32	0.001	1	0.004	0.69	0	0.5	0	0	0.7	0	0.194	0	0	0	0.01
Minimum	0.003	0.05	0.02	0.05	0.068	0.001	0.04	31.4	0.002	0.007	0.005	0.006	0.01		4	0.011	55.5	0.02	0.002	6	0.005	0.04	0.02	13.3	0.03	0.03	4.8	0.01	0.448	0.005	0.005	0.03	0.01
Maximum	0.003	0.05	0.02	0.05	0.133	0.002	0.04	80.4	0.002	0.01	0.005	0.008	0.23		5	0.032	57.9	0.47	0.004	7	0.011	1.02	0.02	14	0.03	0.03	5.8	0.01	0.723	0.005	0.005	0.03	0.02
Median	0.003	0.05	0.02	0.05	0.101	0.002	0.04	55.9	0.002	0.008	0.005	0.007	0.12		4	0.022	56.7	0.24	0.003	6	0.008	0.53	0.02	13.7	0.03	0.03	5.3	0.01	0.586	0.005	0.005	0.03	0.01
Num. Valu	2	2	2	2	2	2	2	2	2	2	2	2	2		2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	

STATION: V43, Vangorda till berm. P-94-02C

STATION: 96-9A. Groundwater at the toe of Grum dump

STATION: 96-98. Groundwater at toe of Grum dumpSTATION: LCD, Little Creek Dam Pond WaterVang98-Metals

APPENDIX 2
1998 BIOASSAY RESULTS

REPORT TO: Anvil Range Mining
Postal Bag 1000
Faro, Yukon, Canada Y0B 1K0
Tel: 867-994-3057

FROM: Cavendish Analytical Labs
1650 Pandora St.
Vancouver, B.C. V5L 1L6
Tel: 604-251-4456

DATE: 13 July 1998

.REPORT ON: RAINBOW TROUT BIOASSAY RESULTS

SAMPLE DESCRIPTION:

IRC Sample ID No.: 9807009
Sample Name: V25 BSP
Date collected: 30 June 1998
Date, time received: 3 July 1998; 1330 hrs.
Collection Method: grab
Amount, Container: 2 x 22 L plastic containers
Physical description: Clear colourless liquid
Date, time tested: 3 July 1998; 1420 hrs.

RAINBOW TROUT 96 HR RESULTS:

The 96 hour (static) LT₅₀ was greater than 96 hours.
The 96 hour (static) LC₅₀ was greater than 100%.
0% trout mortality in undiluted sample.

The LC₅₀ is defined as the mean lethal concentration or the concentration at which there is 50% fish mortality. The LT₅₀ is defined as the mean lethal time or the time at which there is 50% fish mortality. Results are calculated using the method described by Stephan (Methods for calculating an LC₅₀ in: Aquatic Toxicology and Hazard Evaluation, American Society for Testing and Materials, 1977).

The test method followed was as per "Biological Test Method: Reference Method for Determining Acute Lethality of Effluents to Rainbow Trout" EPS 1/RM/13, 1990, amended May 1996. Test volume was ten litres with ten fish in each test vessel. Aeration was by forced air through glass pipettes at a rate of approximately 6.5 ± 1 ml/L/min. **This test was conducted in duplicate.**

The initial dissolved oxygen level was 9.6 mg/L at 15.5°C, the conductivity was 479 μ mhos and the initial pH was 7.3. Sample pH was adjusted from 7.3 to 8.0 with 1N NaOH. After pre-aerating the sample for 30 minutes the dissolved oxygen level was 9.5 mg/L, as this was greater than 70% saturation and less than 100% saturation the test was initiated at this time. The set up technician was MZ.

Please call should you have any questions.

RAW DATA:

<u>TEST</u> <u>CONCENTRATION</u>		<u>HOURS</u>					
		0	1.5	24	48	72	96
REPLICATE 1							
100%							
Percent Survival		100%	100%	100%	100%	100%	100%
Dissolved Oxygen (mg/L)		9.5		9.8	9.6	9.7	9.7
Temperature (°C)		15.5		15.0	15.0	15.0	15.0
pH		8.0		7.7	7.6	7.7	7.7
Conductivity (mhos)		484					493
Symptoms		1	1	1,2	1	1	1
Loading Density (g/L)		0.37	0.37	0.37	0.37	0.37	0.37
REPLICATE 2							
100%							
Percent Survival		100%	100%	100%	100%	100%	100%
Dissolved Oxygen (mg/L)		9.6		8.6	8.4	9.0	8.7
Temperature (°C)		15.5		14.5	14.5	14.5	15.0
pH		8.0		7.6	7.5	7.6	7.6
Conductivity (mhos)		484					495
Symptoms		1	1	1,2	1	1	1
Loading Density (g/L)		0.37	0.37	0.37	0.37	0.37	0.37
CONTROL							
Percent Survival		100%		100%	100%	100%	100%
Dissolved Oxygen (mg/L)		10.0		9.4	9.0	9.7	9.4
Temperature (°C)		15.0		15.0	15.0	15.0	15.0
pH		7.1		7.2	6.9	7.0	7.0
Conductivity (mhos)		37					41
Symptoms		1		1	1	1	1
Loading Density (g/L)		0.37		0.37	0.37	0.37	0.37
Technician		MZ	MZ	JL	BW	BW	BW

KEY TO SYMPTOMS:

- 1 = no apparent effect
 2 = fish showing signs of stress
 3 = loss of equilibrium

TEST FISH STOCK INFORMATION

Date received: 11 June 1998
 Source: Spring Valley Trout Farm
 Species: Oncorhynchus mykiss
 (Rainbow Trout)

Fork Length Mean: 3.55cm $\pm$ 0.19cm
 Range: 3.20cm - 3.90cm

Wet weight: Mean: 0.37g $\pm$ 0.06g
 Range: 0.23g - 0.50g

Condition Factor (100xWt/length³cm): 0.82

Acclimation History: Acclimation temperature: 13 to 14° CELSIUS
 Treatments: None
 Water: Dechlorinated tap water
 Feeding: Moore Clark Fry Feed
 Mortality: less than 2%

RAINBOW TROUT REFERENCE TOXICANT DATA

Stock Arrival Date	Test Date	Toxicant	Log LC50 (mg/L)
97.12.02	98.01.14	Phenol	1.04
97.12.15	98.01.19	"	1.01
97.12.22	98.02.06	"	1.02
98.01.13	98.02.13	"	1.06
98.01.22	98.03.02	"	1.02
98.02.12	98.03.12	"	1.10
98.02.19	98.03.23	"	0.99
98.03.12	98.04.01	"	0.96
98.03.23	98.04.23	"	0.96
98.03.24	98.05.08	"	1.08
98.04.02	98.05.14	"	0.99
98.05.11	98.05.27	"	1.06
98.05.19	98.06.02	"	1.02
98.06.04	98.06.18	"	1.06
98.06.11	98.06.25	"	1.10
LAB MEAN		1.02 mg/L $\pm$ 0.09	

CONTROL/DILUTION WATER QUALITY:

Hardness: 14 mg/L
 Total Residual Chlorine: 0 mg/L

APPENDIX 3

1998 ANNUAL INSPECTION
WASTE AND WATER MANAGEMENT
FACILITIES VANGORDA MINE
YUKON TERRITORY

Report No. 1CA003.01

STEFFEN ROBERTSON AND KIRSTEN INC.
DECEMBER 1998

1CA003.01

**1998 ANNUAL INSPECTION
WASTE AND WATER MANAGEMENT FACILITIES
VANGORDA MINE
YUKON TERRITORIES**

Prepared for:

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DECEMBER, 1998

**1998 ANNUAL INSPECTION
WASTE AND WATER MANAGEMENT FACILITIES
VANGORDA MINE
YUKON TERRITORIES**

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**1998 ANNUAL INSPECTION
WASTE AND WATER MANAGEMENT FACILITIES
VANGORDA MINE
YUKON TERRITORIES**

1. Introduction

At the request of Deloitte and Touche Inc. (DTI), the current Receiver for Anvil Range Mining Corporation, Mr. Peter Healey of Steffen Robertson and Kirsten (Canada) Inc. (SRK) completed an inspection of the waste and water management facilities at Vangorda Plateau Mine on July 23 and 24, 1998. The Vangorda mine is located 16 km south of the Faro Mine, Yukon Territory as shown on Figure 1. The purpose of this inspection was to evaluate the geotechnical performance and stability of the following structures:

- Vangorda Waste Rock Containment Facility including the seepage collection system ;
- Little Creek Dam;
- Vangorda Creek Diversion;
- Sludge Pond Embankments at the Water Treatment Plant,
- Grum Waste Rock Piles;
- The Grum Interceptor Ditch; and
- Sheep Pad Sediment Ponds below the Overburden Stockpile.

A plan of the Vangorda Plateau area and the above components are shown in Figure 2.

This report presents our observations and comments on the performance and stability of the structures and provides recommendations, where appropriate.

Weather at the time of the inspection was sunny.

2. Vangorda Waste Rock Pile

2.1 Background

The Vangorda mine rock containment facility was constructed in May 1990 to contain waste rock from the Vangorda Pit. The two main rock types that were mined from the Vangorda pit include sulphides and phyllites. Geochemical analyses performed on the rock indicated that both rock types have the potential to generate acid rock drainage (ARD). The sulphide rock has a much higher potential for acid generation than the phyllite and therefore the original design called for the construction of separate cells to accommodate the two geochemically different rock types. The purpose of segregating the sulphides from the phyllite was primarily to allow for recovery and processing of the sulphides, should this prove economic at a later date. Segregation would also separate the seepage from each cell so that the effluent could be treated separately, if required.

The original closure plan for the facility required the encapsulation of the mined rock with glacial till that would be stripped during development of the pit. The closure plan was to be implemented progressively as the rock pile expanded. Curragh Resources Inc. (CRI) was the operating mining company when construction of the Vangorda Waste dump began in May, 1990. They built a starter dyke constructed from compacted glacial till, to El. 1135 and a till divider dyke to segregate the rock types. As the waste dump developed, CRI constructed till berms as extensions to the starter dyke around the perimeter of the dump. In most cases, the berms were built to ensure an overall slope of 3:1 (Horizontal to Vertical), however there were a number of areas where the dump was oversteepened making it difficult to achieve the 3:1 slope. As the dump expanded, it became evident that there was more waste than expected and less available till for the berms and the proposed cap, which was to be placed over the top of the dump. The design of the facility was modified in 1992 increasing the ultimate height of the rock dump from 30 metres to 67 metres but maintaining the original footprint of the dump. CRI also looked at alternatives to the till berm and cap concept, such as a 1 or 2m thick till cover over resloped waste as well as on the top of the dump.

CRI also built a seepage collection system around the perimeter of the dump to carry seepage to the ARD collection pond known as Little Creek Pond.

In November 1993, during the period when the mine was in receivership, Government Services of Canada (GSC) commissioned Pelly Construction Limited (PCL) to upgrade the Vangorda dump seepage collection system and initiate work on the resloping and capping of the waste within the dump. SRK was retained by PCL to provide engineering consulting services for the work.

The work involved the upgrading of the existing seepage collection system located around the perimeter of the containment facility, recontouring rock slopes within a section of the rock pile, and providing instrumentation to monitor both the physical stability of the rock pile, and any impact on the groundwater quality. Upgrading of the seepage collection channel started in March 1994 and was completed by mid June 1994. The resloping of the waste rock and the placement of the till cover began on May 6, 1994 and was completed by the middle of June, 1994.

During construction of the seepage channel and the resloping of the rock pile, permanent instrumentation was installed to monitor any seepage from the waste rock pile and potential seepage losses from the channel and piezometric heads that may develop in the existing till berm around the pile. The instrumentation included weirs, groundwater wells and piezometers.

During this period, the receiver at the time also commissioned Golder and Associates to install pneumatic piezometers and thermistors in the earth dam at Little Creek Pond

In the fall of 1998, DIAND made funds available to the Ross River Dena Development Corporation to initiate remediation of the Vangorda Waste Dump. The work involved moving about 12,000 cubic metres of sulphide rock that had been stockpiled outside the boundary of the waste dump to an area within the dump.

This fall, DTI also authorized the installation of an emergency spillway in the Little Creek Dam.

2.2 Observations

2.2.1 Seepage Collection System

2.2.1.1 Channel Berm

At the outlet of the seepage channel and at the south abutment of the Little Creek Dam, a small depression still exists causing ponding of water (Photo 1). The remaining sections of the dyke show no signs of settlement, cracking or sloughing.

2.2.1.2 Transverse Drains and Weirs

During construction of the original till berm, six transverse drains were installed beneath the berm to allow seepage to drain from the waste dump. These drains were connected to the seepage collection channel during the 1994 upgrading.

During this years inspection, flow was observed in Drains 3, 5 and 6 only. The v-notch weirs used to monitor the flow, are functioning adequately. However maintenance is required at Weir 6. Large erosion gullies have developed in the starter dyke above Weir 6 caused by runoff from the access road above the weir (Photo 6). Silt has built up behind the weir and is impeding the flow through the notch. The eroded material has also covered the outlet of the transverse drain. Weirs 2, 3 and 5 are shown in Photos 2, 3 and 4 respectively.

2.2.1.3 Seepage Channel

No instability of the sideslopes of the seepage channel was observed. Seepage from the transverse drains at Weir 3 is entering the channel, however no flow was observed at the outlet of the channel as it enters Little Creek Pond. This is attributed to a number of causes including the relatively low flow (2-3L /min) from the drain at Weir 3, the build up of fines along the bottom of the channel, which have washed down from the broken rock on the sideslopes, evaporation during the summer months and the relatively shallow gradient of the channel.

2.2.2 Starter Dyke and Till Cover

Erosion of the downstream face of the till starter dyke continues but to date there has been no major subsidence or instability. However, there is one area adjacent to Weir 3 where till was at some point removed from the toe of the slope to build an earth structure. This excavation poses a potential risk to the stability of the dyke at this section with a possible loss of the piezometers above (P94-01A) (Photo 6). One other area of potential concern is below piezometers P94-3A and 3B. The erosion in this area also presents a threat to the stability of the wells.

The till cover that was placed over the regraded waste rock on the south side of the Vangorda Dump has performed well with only a limited amount of erosion. There is one area at the toe of the till cover where erosion of the original till starter berm has occurred and causes a build-up of sediment and fines, which overflows into the seepage collection channel (Photos 7). The erosion is caused by runoff from the till cover and resloped areas, which concentrates in the area where till placement was terminated in 1994. This problem will be resolved once the till cover is completed and runoff is allowed to flow more uniformly across the slope.

2.2.4 Instrumentation

DTI has been taking water level readings from the nine piezometers and four of the five groundwater wells around and within the facility. A summary of the water level readings taken to date in both the piezometers and the groundwater wells is presented in Table 1. Water levels, as recorded on November 16, 1998 in Piezometers P94-01A, 01B, 02A and 02B, are shown in Figures 3 and 4. A plot of the historical readings for these piezometers is shown on Figure 5. The water levels in the piezometers continue to remain generally static with minor fluctuations.

2.2.5 Rock Pile

Tension cracks are still evident in places along the crest at the north east end of the dump. The cracks have not widened since SRK last inspected the rock pile in 1998.

TABLE 1: VANGORDA ROCK DUMP PIEZOMETERS - STATIC WATER LEVELS AND PIEZOMETRIC ELEVATIONS

Measured Static Water Level (meters)

underlined readings (begin in 1998) indicate that no water was identified (hole was dry or frozen)

Date	V34 GW-94-01	V35 GW-94-02	V36 GW-94-03	V37 GW-94-04	V38 GW-94-05*	V39 P-94-01A	V40 P-94-01B	V41 P-94-02A	V42 P-94-02B	V43 P-94-02C	V44 P-94-03A	V45 P-94-03B	V46 P-94-04A	V47 P-94-04B
3-May-94	8.28	14.33	11.28	14.33	11.56	12.37	6.05	10.57	6.12	13.08	14.10	9.80	12.17	8.99
21-Jun-94	7.45	8.65	9.15	9.65										
30-Jun-95						7.79	5.62	8.02	6.11	9.02	13.91	9.80	11.35	8.99
13-Jul-95						7.80	5.59							
30-Jul-95						7.86	5.48	7.99	6.12	8.81	13.68	9.80	11.83	8.99
26-Aug-95	6.89	8.47		9.05										
31-Aug-95	7.36					7.93	4.85	7.97	6.06	8.66	13.62		12.60	
17-Oct-95	7.14	8.26		9.37		7.90	4.23	8.70	5.76	8.54	13.41		11.88	
20-Nov-95	7.10	8.18		9.19										
13-Mar-96	7.44	9.23		9.39										
28-May-96	7.50	9.34	10.00	10.25		8.34	5.38	9.94	6.12	9.37	14.12		12.77	
24-Sep-96	7.50	7.43	7.95	9.17		10.40	5.30	8.30	6.12	8.66	13.68	9.88	12.80	8.99
13-May-97	6.84	9.42	9.96	9.53		9.17	5.67	7.74	6.40	9.51	12.78	9.96	12.78	9.62
11-Jul-97						9.80	5.90	7.92	6.12	8.97	14.10	9.80	9.97	9.00
11-Aug-97	6.75	8.38	8.41	8.81	1.99	9.59	5.25	8.10	6.25	8.77	12.84	9.96	12.62	9.21
14-Oct-97	6.76	8.58	9.15	8.99		9.51	4.96	7.99	6.23	8.94	12.96	9.96	12.73	9.21
23-Dec-97	6.70	9.05	9.53	9.13		9.25	4.76	7.68	6.07	8.95	12.70	9.81	12.66	9.02
31-May-98	6.72	8.60	9.73	9.59	1.86	9.52	5.25	8.05	6.24	9.20	12.87	9.95	12.77	9.20
25-Jul-98						10.20	5.22	8.04	6.20	9.11	12.58	9.92	12.79	9.18
15-Sep-98	6.67	8.85	9.52	9.10	2.40	10.02	5.22	7.98	6.20	9.22	12.54	9.92	12.83	9.19
16-Nov-98						10.32	5.11	7.93	6.11	9.06	12.45	9.78	12.70	8.99

* depth to bottom of hole GW-94-05 (V38) checked as 14.7m on Sep 15/98.

Top of Pipe Elevations (masl)

V34 GW-94-01	V35 GW-94-02	V36 GW-94-03	V37 GW-94-04	V38 GW-94-05	V39 P-94-01A	V40 P-94-01B	V41 P-94-02A	V42 P-94-02B	V43 P-94-02C	V44 P-94-03A	V45 P-94-03B	V46 P-94-04A	V47 P-94-04B
1117.445	1117.405	1118.431	1116.165	1101.673	1136.555	1136.493	1138.41	1138.332	1129.84	1134.373	1134.459	1134.609	1134.327

Piezometric Elevation (masl)

Date	V34 GW-94-01	V35 GW-94-02	V36 GW-94-03	V37 GW-94-04	V38 GW-94-05	V39 P-94-01A	V40 P-94-01B	V41 P-94-02A	V42 P-94-02B	V43 P-94-02C	V44 P-94-03A	V45 P-94-03B	V46 P-94-04A	V47 P-94-04B
3-May-94	1109.165	1103.075	1107.151	1101.835	1090.113	1124.185	1130.443	1127.84	1132.212	1116.76	1120.273	1124.659	1122.439	1125.337
21-Jun-94	1109.995	1108.755	1109.281	1106.515										
30-Jun-95						1128.765	1130.873	1130.39	1132.222	1120.82	1120.463	1124.659	1123.259	1125.337
13-Jul-95						1128.755	1130.903							
30-Jul-95						1128.695	1131.013	1130.42	1132.212	1121.03	1120.693	1124.659	1122.779	1125.337
26-Aug-95	1110.555	1108.935		1107.115										
31-Aug-95	1110.085					1128.625	1131.643	1130.44	1132.272	1121.18	1120.753		1122.009	
17-Oct-95	1110.305	1109.145		1106.795		1128.655	1132.263	1129.71	1132.572	1121.3	1120.963		1122.729	
20-Nov-95	1110.345	1109.225		1106.975										
13-Mar-96	1110.005	1108.175		1106.775										
28-May-96	1109.945	1108.065	1108.431	1105.915		1128.215	1131.113	1128.47	1132.212	1120.47	1120.253		1121.839	
24-Sep-96	1109.945	1109.975	1110.481	1106.995		1126.155	1131.193	1130.11	1132.212	1121.18	1120.693	1124.579	1121.809	1125.337
13-May-97	1110.605	1107.99	1108.476	1106.635		1127.385	1130.823	1130.67	1131.932	1120.33	1121.593	1124.499	1121.829	1124.707
11-Jul-97						1126.755	1130.593	1130.49	1132.212	1120.87	1120.273	1124.659	1124.639	1125.327
11-Aug-97	1110.695	1109.025	1110.021	1107.355	1099.683	1126.965	1131.243	1130.31	1132.082	1121.07	1121.533	1124.499	1121.989	1125.117
14-Oct-97	1110.685	1108.825	1109.281	1107.175		1127.045	1131.533	1130.42	1132.102	1120.9	1121.413	1124.499	1121.879	1125.117
23-Dec-97	1110.745	1108.355	1108.901	1107.035		1127.305	1131.733	1130.73	1132.262	1120.89	1121.673	1124.649	1121.949	1125.307
31-May-98	1110.725	1108.805	1108.701	1106.575	1099.813	1127.035	1131.243	1130.36	1132.092	1120.64	1121.503	1124.509	1121.839	1125.127
25-Jul-98						1126.355	1131.273	1130.37	1132.132	1120.73	1121.793	1124.539	1121.819	1125.147
15-Sep-98	1110.775	1108.555	1108.911	1107.065	1099.273	1126.535	1131.273	1130.43	1132.132	1120.62	1121.833	1124.539	1121.779	1125.137
16-Nov-98						1126.235	1131.383	1130.48	1132.222	1120.78	1121.923	1124.679	1121.909	1125.337

2.3 Recommendations

2.3.1 Seepage Collection Channel

2.3.1.1 Channel Berm

SRK recommends that DTI backfill the depression at the south abutment of Little Creek Dam with locally available till and compact with several passes of a dozer. Monthly monitoring of the area should be conducted for any signs of further settlement.

2.3.1.2 Transverse Drain and Weirs

To minimise the erosion and silt build-up in Weir 6, DTI should divert the runoff from the road above, away from the weir. DTI should also clean out the silt in the area behind the weir and remove the loose material from the face of the drain to expose the granular filter material in the underdrain.

2.3.2 Till Covers and Berms

In the upper reaches of the seepage collection channel, DTI should remove any silt that has accumulated in the channel. When the next phase of till cover is placed, this area would be recontoured and the sediment problem would be reduced. In the meantime, DTI should continue to monitor the silt build-up and periodically remove the material.

DTI should also place backfill up against the toe of the starter dyke where material has been removed.

2.3.3 Instrumentation

Water level readings should continue to be taken from both the groundwater wells and the standpipe piezometers in the till berm around the rock pile. These readings should be taken semi-annually with close attention given to the water levels in P94-01A and B, and P94-02A, 02B and 02C.

Water quality samples should continue to be taken from the groundwater wells around the Vangorda Waste dump.

2.3.4 Rock pile

DTI should continue to regularly monitor the cracks observed on the surface of the rock fill. Any widening of these cracks should be reported.

3. Little Creek Dam

3.1 Observations

The Little Creek dam is an earth embankment, which was constructed in 1990 to collect water pumped from the Vangorda Pit and seepage from the Vangorda rock pile.

The water level in the pond at the time of our inspection was about 4 metres below the dam crest at an elevation of about 1110.1 m.

There was no evidence of any slides or sloughing, nor signs of any cracks or movement along the crest of the dam (Photo 8). Runoff from the eastern approach road continues to cause erosion of the road embankment sideslopes. Two erosion gullies (Photo 10), which are in places 1m deep, have formed within several metres of each other. These gullies pose no immediate threat to the stability of the dam itself but if allowed to go unchecked could result in loss of a section of the road. Runoff has been allowed to flow over the slope through "punch outs" in the berm along the side of the road. An attempt has also been made to direct runoff from the approach road over the downstream side of the approach road (Photo 11).

The downstream face of the dam (Photo 9) shows little evidence of surficial movement, bulging or instability. The loose, uncompacted material at the toe of the dam, which was deposited during the construction of the dam in 1991, shows signs of continued erosion.

In 1994, six pneumatic piezometers and three thermistors were installed along the crest of the Little Creek dam. The six piezometers are located at three separate locations; two piezometers, one deep and one shallow, at each location. The location of the piezometers and thermistors are shown on Figure 6 and the most recent piezometric levels (Sep 98) are shown in section on Figures 7 and 8. Actual readings are included in Appendix B.

Previously, SRK has recommended that an emergency spillway be installed at the north abutment of Little Creek Dam. In early fall of this year DTI, authorized the design and construction of an emergency spillway at the south abutment of Little Creek dam. The work was carried out between September and October, 1998. Details of the design and construction activities are presented in an SRK report entitled "Little Creek Dam, Emergency Spillway, Vangorda Mine, December 1998.

During the inspection, no seepage was observed at along the toe of the downstream dam.

Water is currently being pumped directly from a floating raft on the pond to Vangorda Pit (Photo 12). The treatment plant is not in operation.

3.2 Recommendations

The mine should continue to regularly monitor the crest of the dam for any cracks, settlement or surficial movement of the slope.

The piezometric levels are consistent with the water levels recorded in the impoundment and are in accordance with the design safety factors associated with the stability of the dam. The thermistor readings are also consistent.

SRK recommends that the pneumatic piezometers and thermistors be monitored on a semi-annual basis and the results compiled and forwarded to SRK.

It is recommended that the runoff from the approach road be directed into a CMP culvert constructed in the approach road. The culvert would feed into a rock filled spillway down the face of the embankment. The spillway could be constructed at the location of one of the existing erosion gullies by excavating out a channel and placing riprap size material over a layer of non woven geotextile. An alternative to the spillway construction would be to backfill the gullies and place a half-round culvert section down the slope. Furthermore, the road surface should be regraded to promote drainage off the crest and a 150mm layer of 20mm minus sand and gravel should be placed and compacted on the crest.

DTI should, with the aid of a small cat, blade the downstream face of the dam to remove loose material. The excess material should be removed away from the toe and work should be carried out in dry conditions. DTI should consider vegetating the downstream face of the dam to minimise erosion.

Additional recommendations regarding the recently constructed emergency spillway and the continued operation of the pond are included in the spillway design and construction report (SRK, 1998).

4. Vangorda Creek Diversion

4.1 Observations

The crest of the dam at the headworks of the Vangorda Creek Diversion shows no signs of settlement or cracking. There is no evidence of instability or surficial movement on either of the upstream and downstream faces. Some riprap has been lost above the inlet to the CMP at the headworks of the diversion (Photo 13 and 14) exposing the underlying geotextile. Furthermore, riprap has begun to collect in the channel and around the trash rack at the inlet to the CMP narrowing the entrance. The pipe itself appears to be sound.

The half-round culvert in the upper reaches has performed well (Photo 15) but the flume does not weather well along the lower reaches (Photo 16). The cross bars are badly bent and the flume is buckled in places. In several areas along the flume, riprap has settled to below the lip of the culvert (Photo 17). The potential still remains for slide debris at certain locations along the channel to enter the flume.

In some places, there has been further loss of the fine bedding material on each side of the flume, which has resulted in settlement of the riprap in the channel. Side boards have been installed along the channel in an attempt to control the flow during spring flow.

There has been further riprap loss at the outlet end of the flume where it enters the stilling basin and the sideslopes of the basin remain susceptible to erosion (Photo 18).

4.2 Recommendations

DTI should place additional riprap in the areas above the entrance to the 1800 mm diameter culvert at the headworks of the diversion. The riprap should at least cover the exposed geotextile.

There are several areas along the flume where the riprap continues to settle below the top of the flume. Additional riprap should be placed in these areas to protect the flume and to bring the overflow channel back to grade.

In the area where the hillside is prone to sloughing, regularly monitoring should be carried out and any subsidence should be removed from the flume and/or overflow the channel.

The stilling basin requires additional riprap protection to control erosion and subsidence of the sideslopes.

DTI should review the capacity of the system at the outlet of the flume to ensure that it can handle the increased flow from the settling pond during the 100 year design event.

Additional riprap should be placed around the inlet to the 2m diameter pipe, which takes the flow to the drop box structure (Photo 19).

5. Sludge Pond Embankment-Vangorda Water Treatment Plant

5.1 Observations

There was no evidence of any major instability on the downstream face of the surrounding dyke. However, small rills were evident on the downstream face of the dyke as a result of runoff from the crest and there are signs of previous surface movement on the slope in the southwest corner of the pond. The sloughed material is current covered with vegetation.

Longitudinal tension cracks were also observed in a number of places along the crest of the dyke (Photo 20). These cracks, which vary in length up to 30 m long in places and are typically 1 to 2cm wide, were observed last year and have not worsened. Discontinuous cracks and minor slumps were also observed in a number of places along the upstream face of the dyke.

At the time of our inspection, the water level in the pond was about 5 metres below the crest and the treatment plant was shut down.

5.2 Recommendations

The following actions should be taken at the Water Treatment Plant:

- Fill in or blade over tension cracks both in the crest and along the upstream face to prevent entry from runoff and precipitation.
- Weekly inspection of the upstream face and the crest for further development of the cracks is recommended
- Maintain an operating pond level of no greater than 2m below the crest elevation.

6. Grum Settling Pond

6.1 Observations

This facility was constructed by the mine to store seepage pumped from the Grum Pit. The pond is approximately 100 m by 60 m in plan dimension and was constructed as a cut and fill sidehill impoundment with three sides. The embankments were constructed of glacial till with the inside sideslopes of the impoundment at about 2.5:1 (H:V) and a crest width of about 5 m. The inside sideslopes were compacted with the tracks of a dozer. The downstream slopes of the embankment vary from 1.3:1 to 1.5:1.

At the time of our inspection the pond level was 3m below the crest and no seepage was noted along the toe of the dyke.

6.2 Recommendations

The crest of the embankment should be monitored monthly for cracks and the pond level should not exceed 1.0 m below crest. Seepage into and out of the pond should also be monitored.

Runoff control using berms or diversion ditches should also be adopted to reduce erosion of the slopes.

Regular monitoring along the toe of the embankment for seepage is recommended.

7. Grum Interceptor Ditch and Sheep Pad Settling Pond

7.1 Observations

The Grum Interceptor Ditch (GID) (Photos 21 to 23) was constructed to divert runoff away from the pit and into sedimentation ponds (Sheep Pad) below the overburden stockpile. The sideslopes of the channel in the upper reaches are sloped at 2:1 (H:V), and are unlined.

Work has continued on the riprapping of the slopes of the GID but there are areas that will need to be riprapped as soon as possible. In the upper reaches, the slopes have performed well. Below the treatment plant, however, there is a section of the ditch where the grade steepens and the sideslopes have subsided narrowing the channel (Photo 23). No riprap has been placed on the sideslopes in this area.

At the inlet and outlets of some of the culverts, the sideslopes have eroded and are unstable.

The last culvert before the flow discharges into the sediment ponds (Photo 24) has been damaged and the road fill above the culvert is badly eroded.

Water level in the ponds is lower than normal and the water was noticeably clear. Very little flow was noted in the exit channel below the lower pond.

No significant seepage along the toe of the embankment

7.2 Recommendations

The following actions are recommended:

- place riprap (shotrock) around inlets and outlets of all culverts where applicable to prevent erosion and sediment build-up. Geotextile should be placed against the exposed soil prior to placing the riprap;
- Monitor for tension cracks in the settling pond dykes, on the crest and on the upstream and downstream slopes;
- Monitor for seeps that develop along the toe of the dykes;
- Remove sloughed material in the ditch section of the GID referenced above and place geotextile and riprap on the sideslopes;
- Reconstruct the culvert at the entrance to the upper pond.

This Report, 1CA003.01 - 1998 Annual Inspection Waste and Water Management Facilities Vangorda Mine, Yukon Territories has been prepared by:

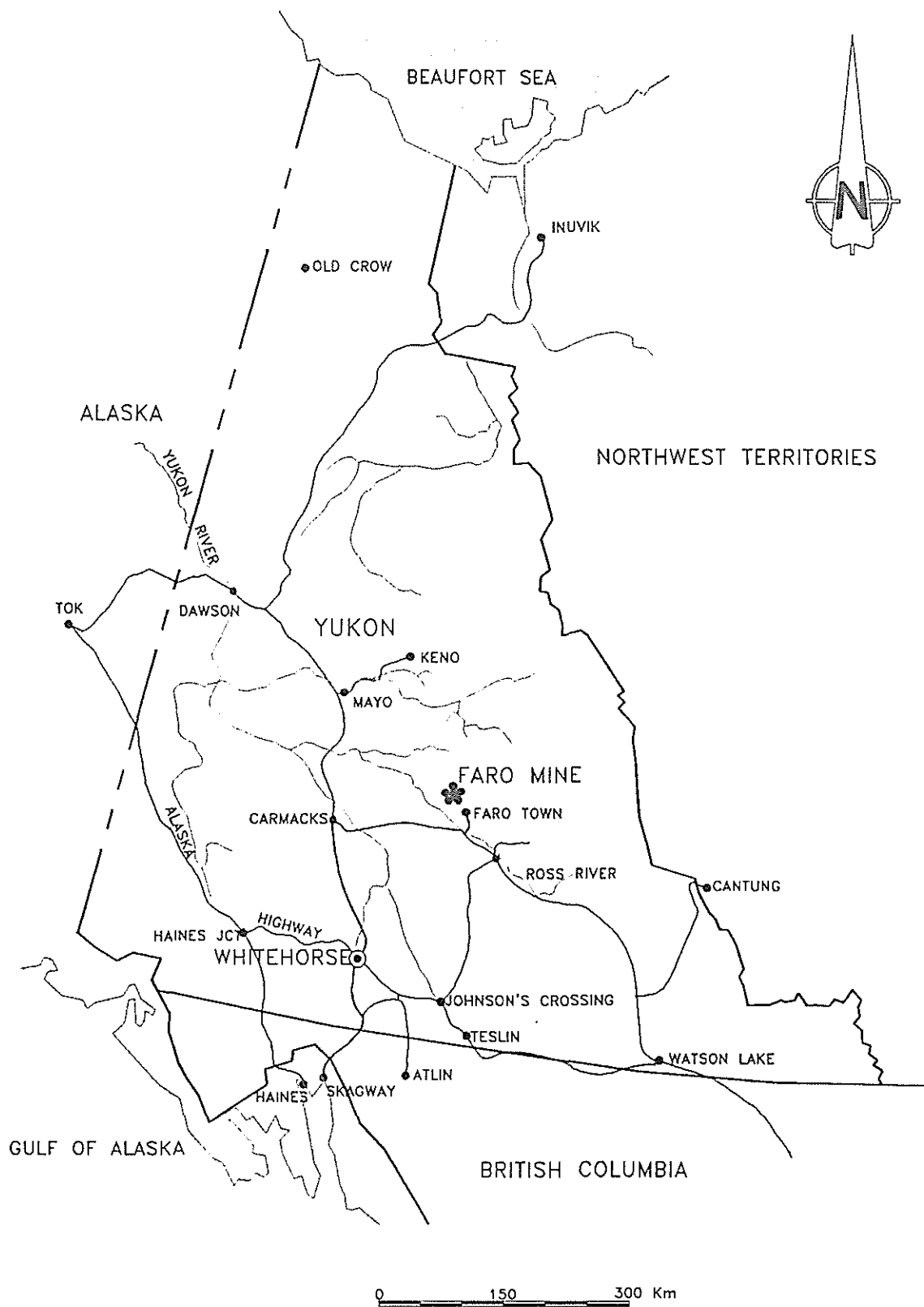
STEFFEN ROBERTSON AND KIRSTEN (CANADA) INC.



Peter Healey, P.Eng.

Senior Project Engineer, GeoEnvironmental

Figures



STEFFEN ROBERTSON AND KIRSTEN
Consulting Engineers

DELOITTE & TOUCHE LTD.

VANGORDA PLATEAU MINE

LOCATION MAP

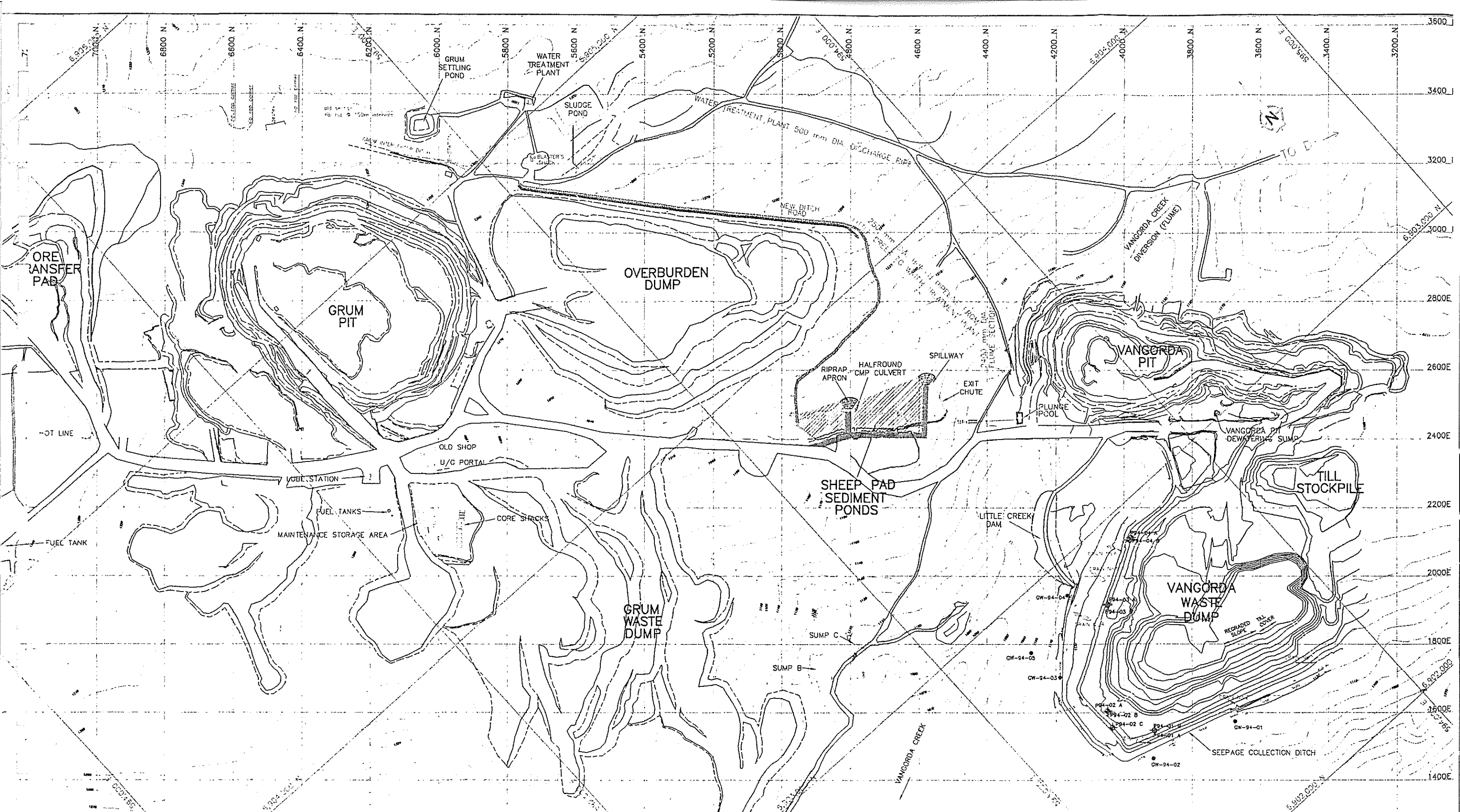
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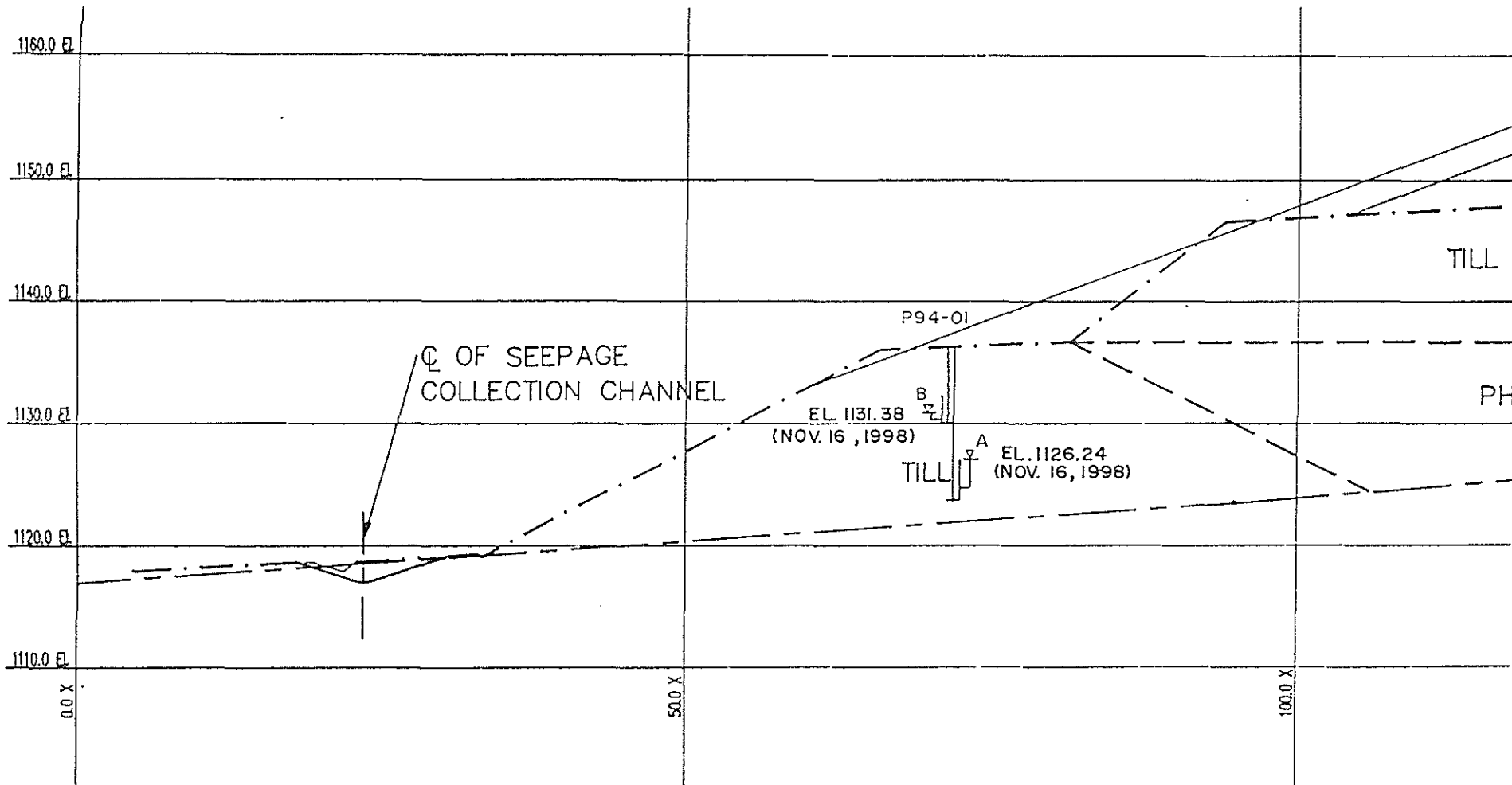
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FIGURE

1





SCALE 1:500

NOTE: READINGS TAKEN NOV.16, 1998



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VANGORDA PLATEAU

SECTION D-3
CHANNEL STA. 4+80

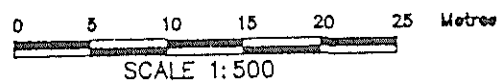
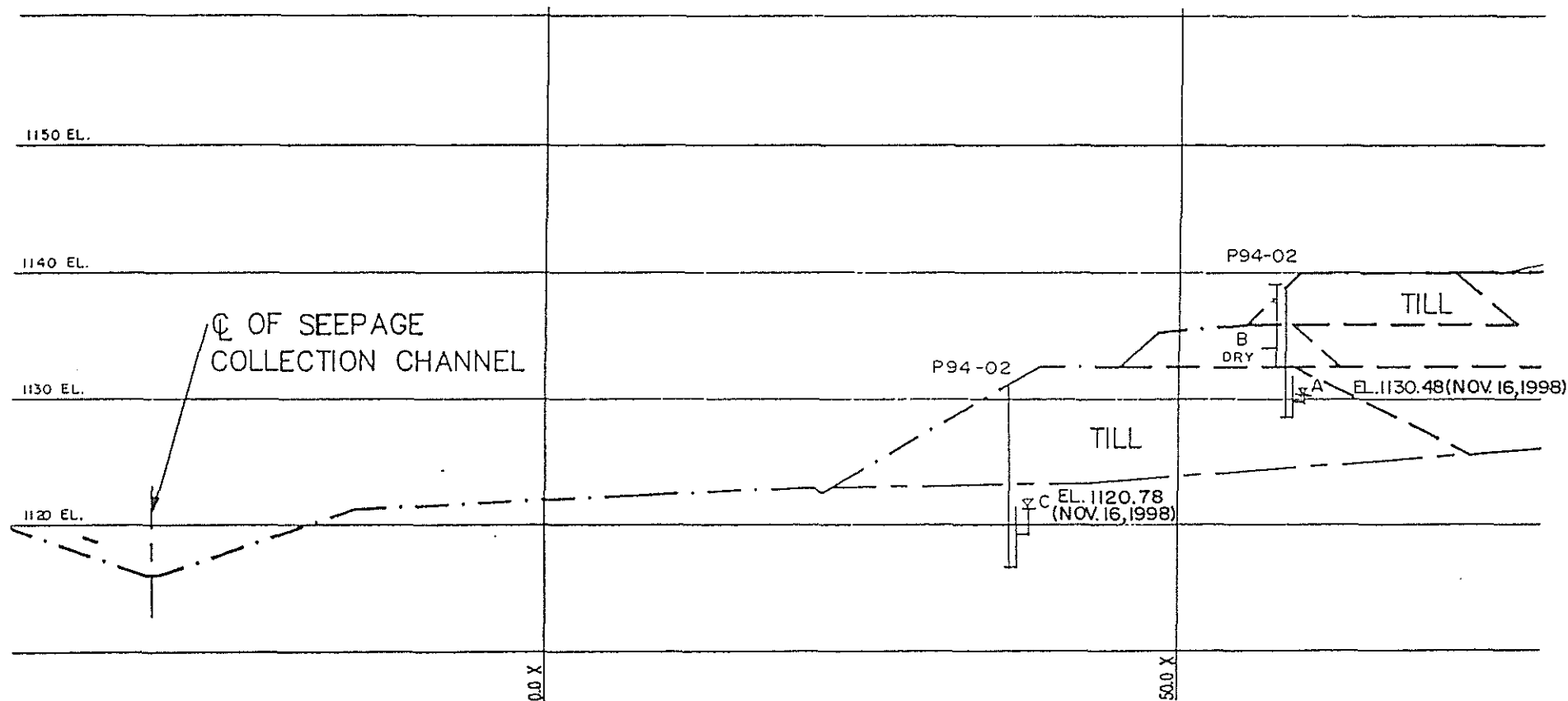
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FIGURE

3



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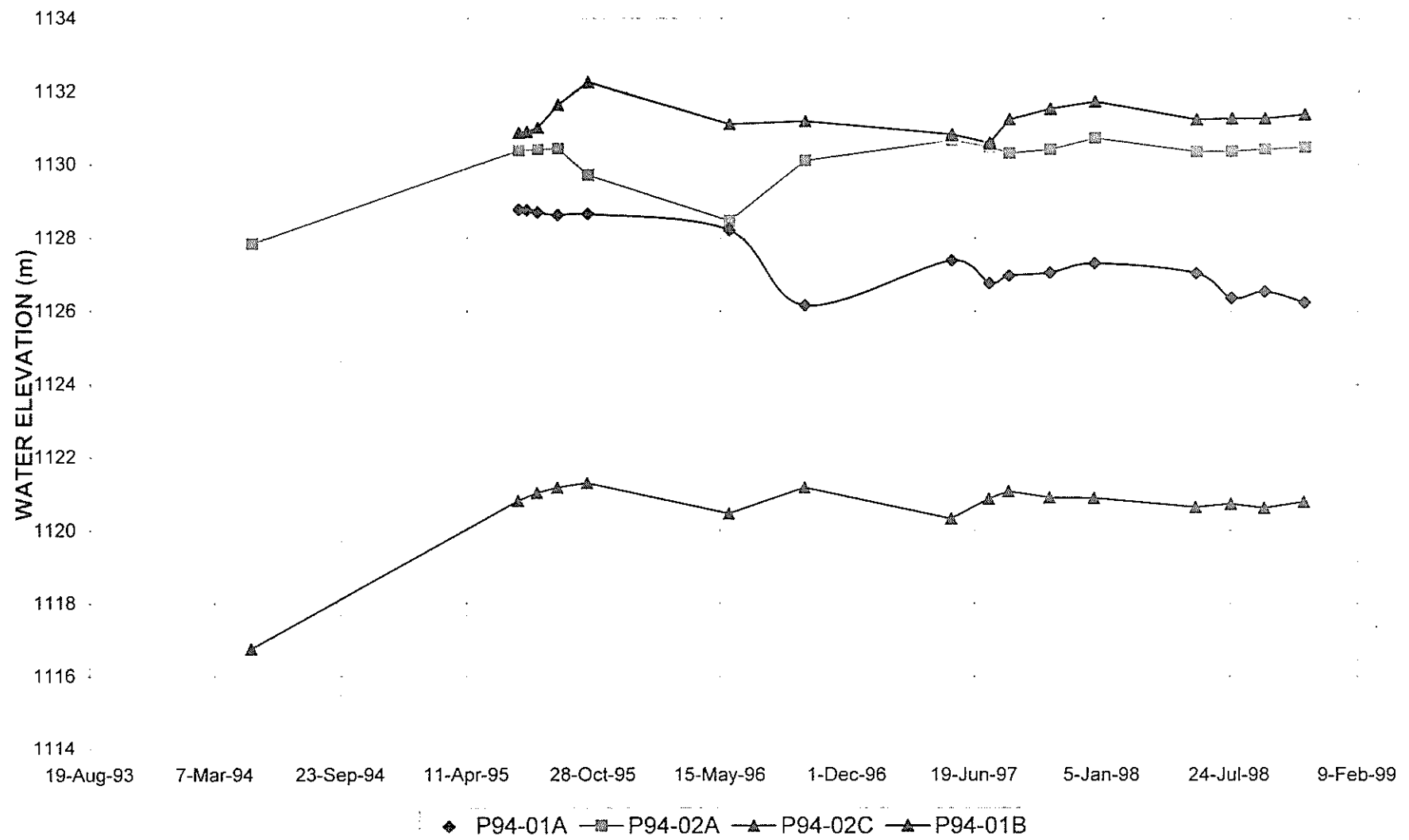
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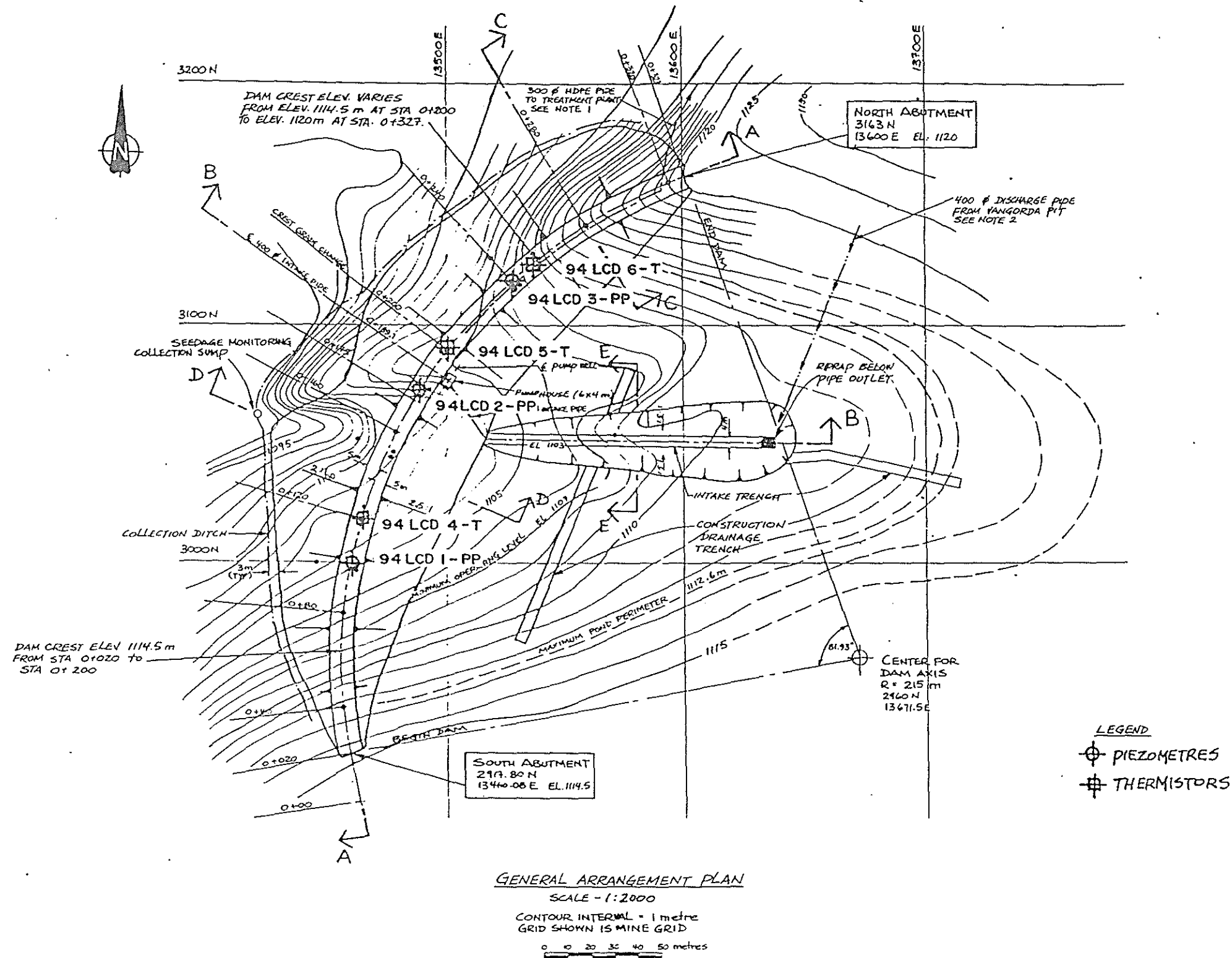
VANGORDA PLATEAU

SECTION D-4
CHANNEL STA. 9+00

PROJECT NO. ICA003.01	DATE DEC. 1998	APPROVED	FIGURE 4
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FIGURE 5: PIEZOMETRIC LEVELS- VANGORDA WASTE DUMP





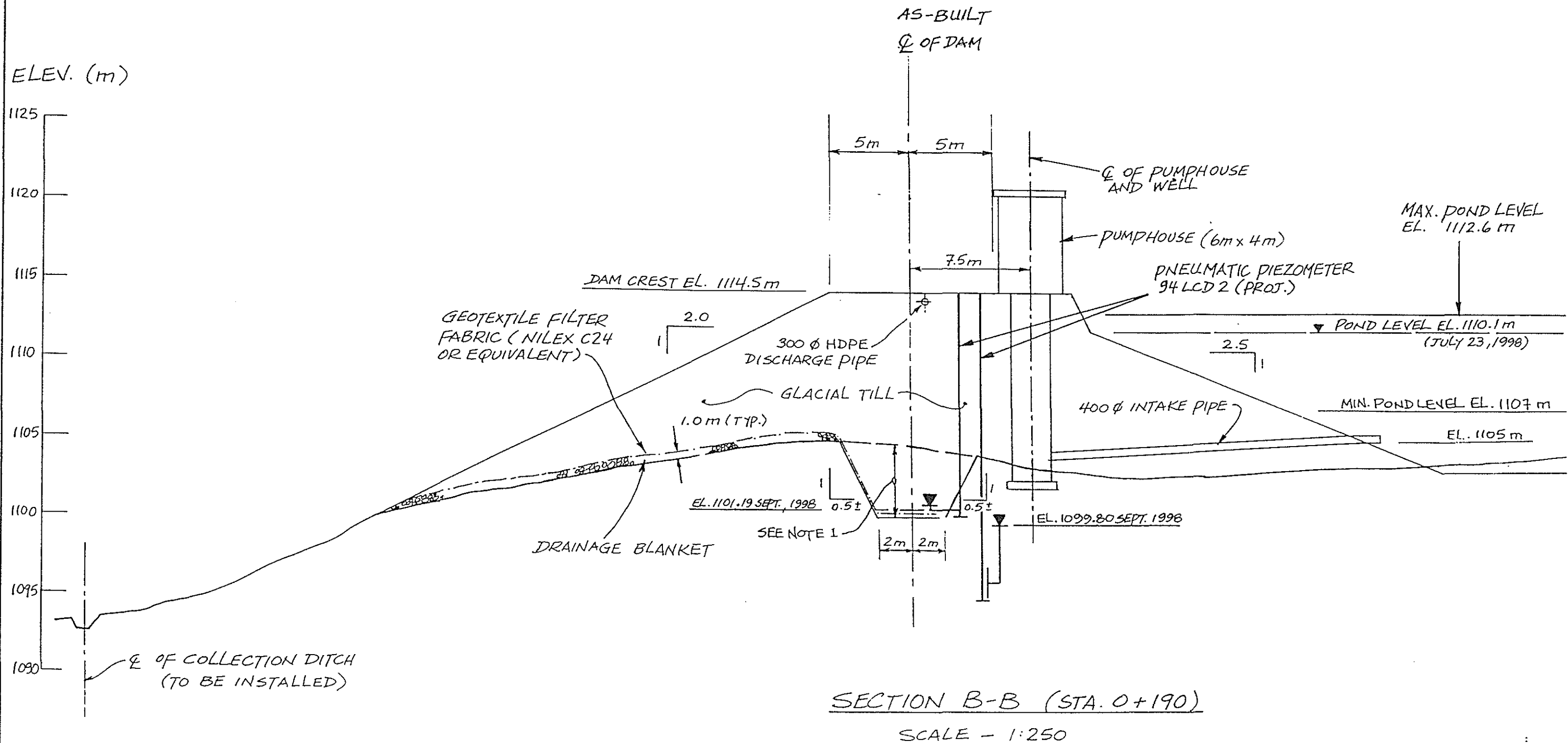
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VANGORDA PLATEAU MINE

LITTLE CREEK DAM GENERAL ARRANGEMENT PLAN

PROJECT NO ICA003.01	DATE DEC. 1998	APPROVED	FIGURE 6
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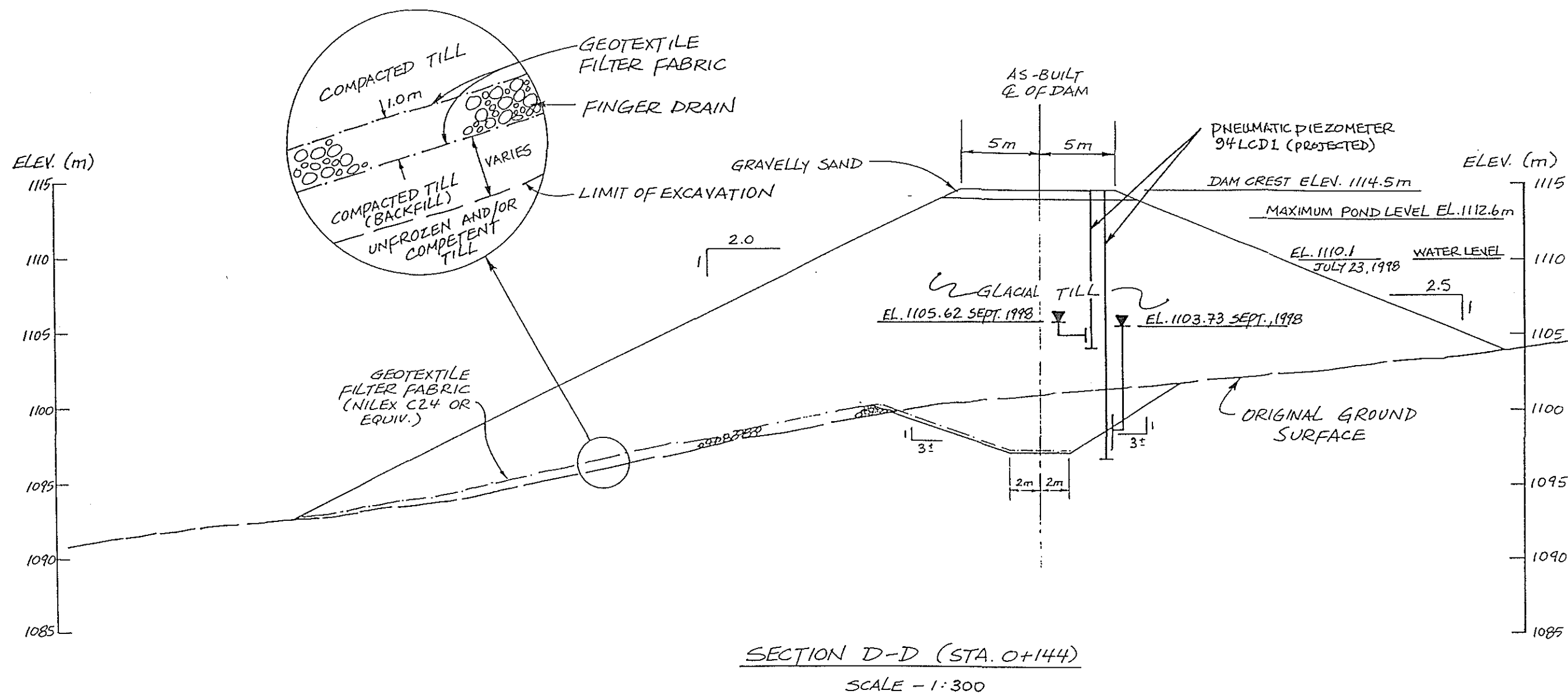
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VANGORDA PLATEAU MINE

LITTLE CREEK DAM
SECTION B-B

PROJECT NO. ICA003.01	DATE DEC. 1998	APPROVED	FIGURE 7
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LITTLE CREEK DAM
SECTION D-D

PROJECT NO
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DEC. 1998

APPROVED

FIGURE
8

APPENDIX A

Photos



Photo 1 - Small depression at south abutment of Little Creek Dam.

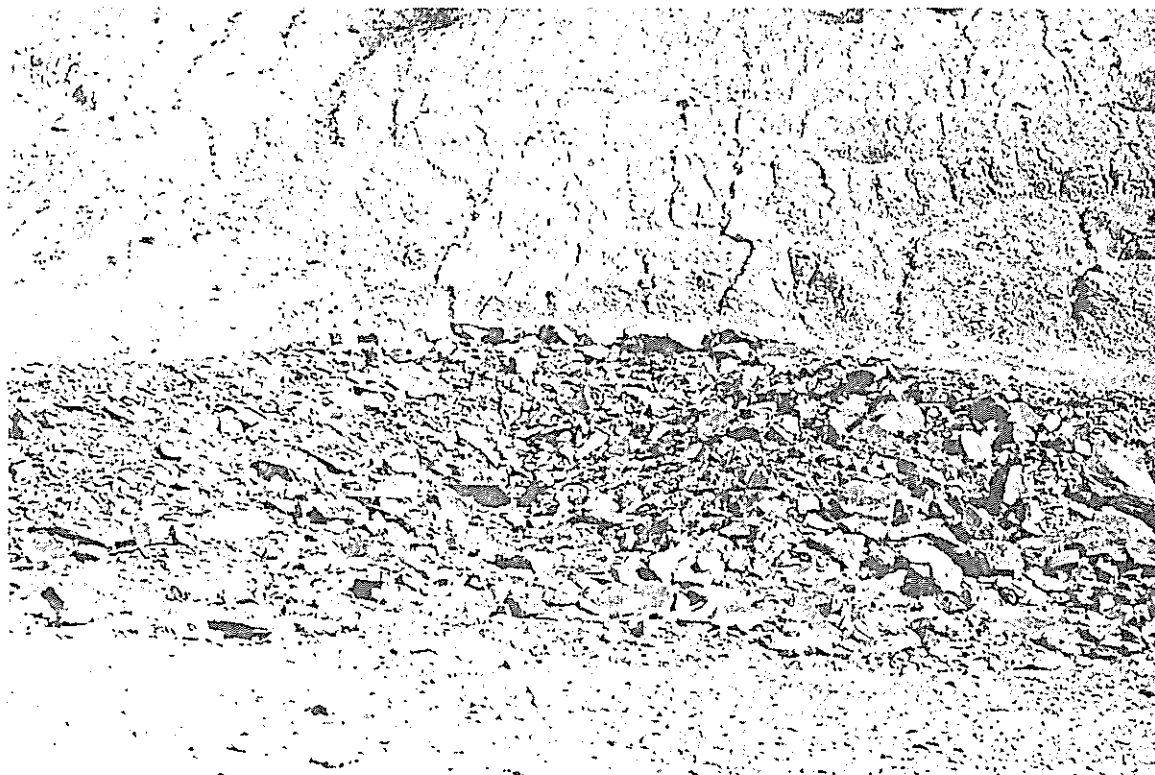


Photo 2 - V-notch weir at outlet of No. 2 drain from waste dump.

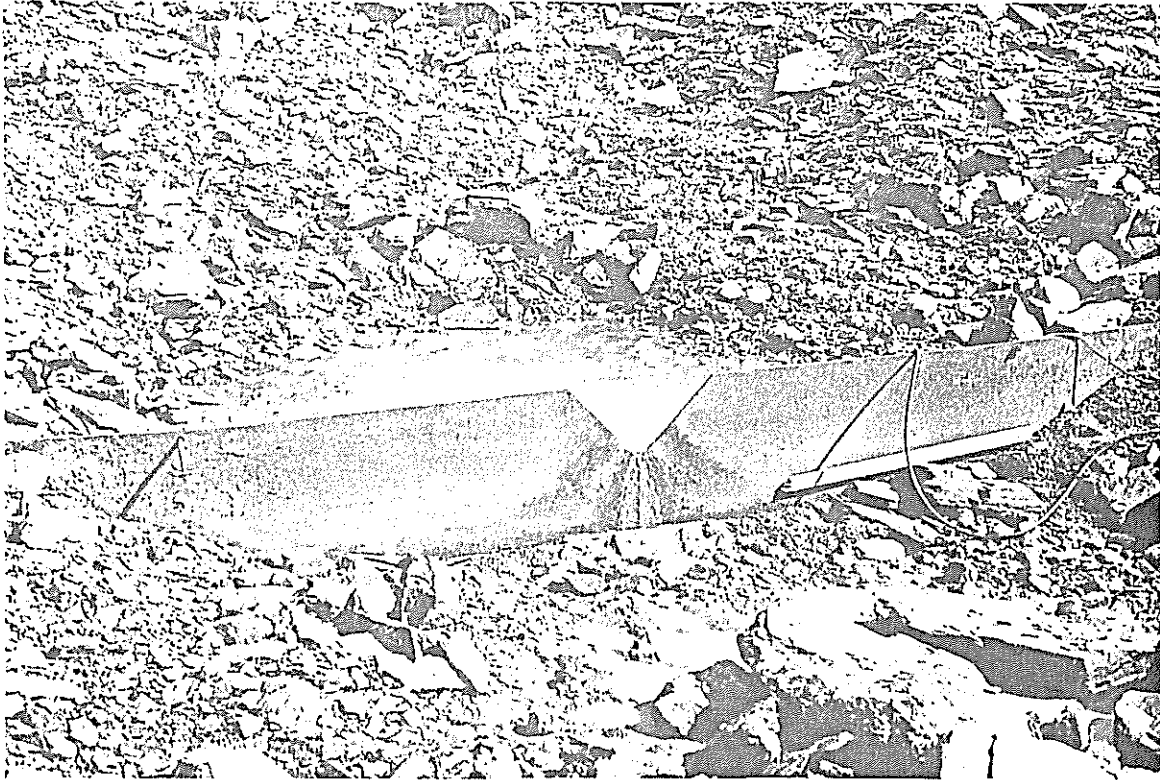


Photo 3 - Weir at drain 3.



Photo 4 - Weir at drain 5.



Photo 5 - Weir at drain 6.



Photo 6 - Excavation above weir 3.



Photo 7 - Erosion of till dyke below till cap.

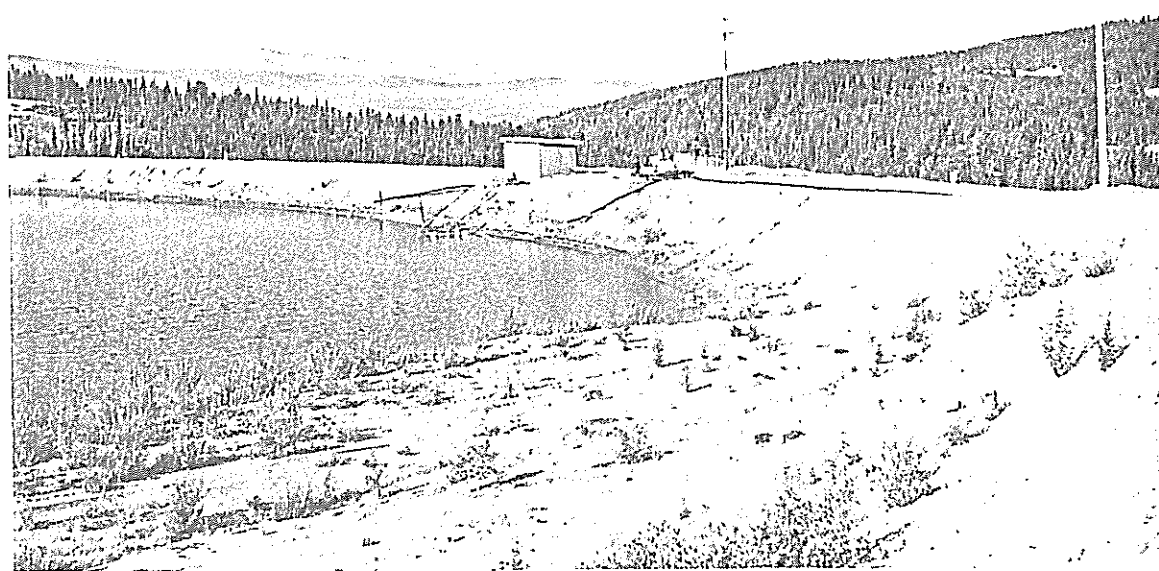


Photo 8 - Little Creek Dam.



Photo 9 - Downstream slope of Little Creek Dam.

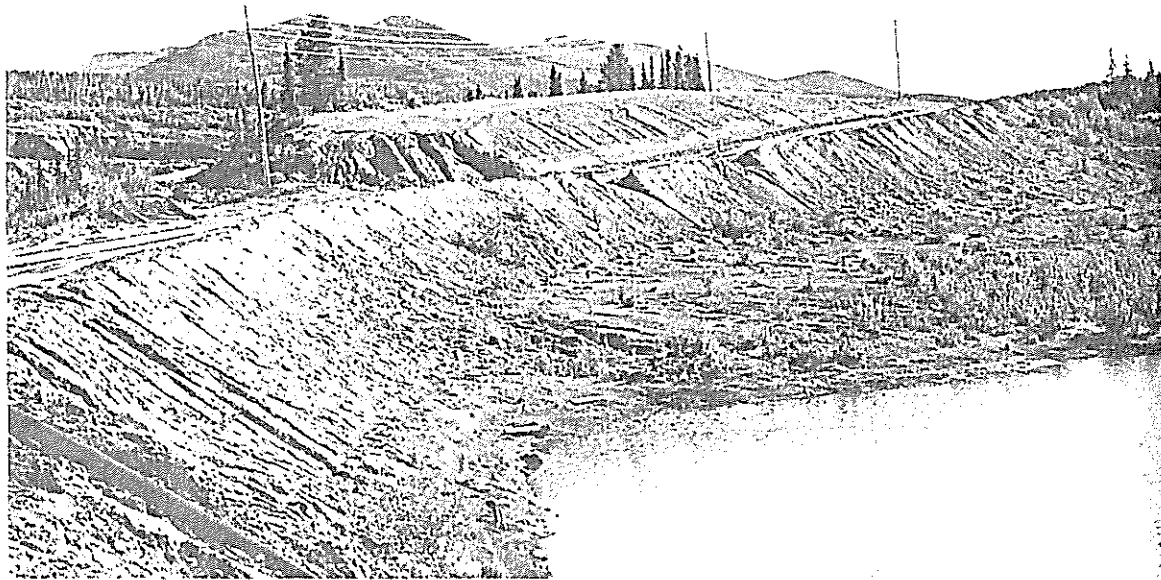


Photo 10 - Approach road to Little Creek Dam at north abutment.

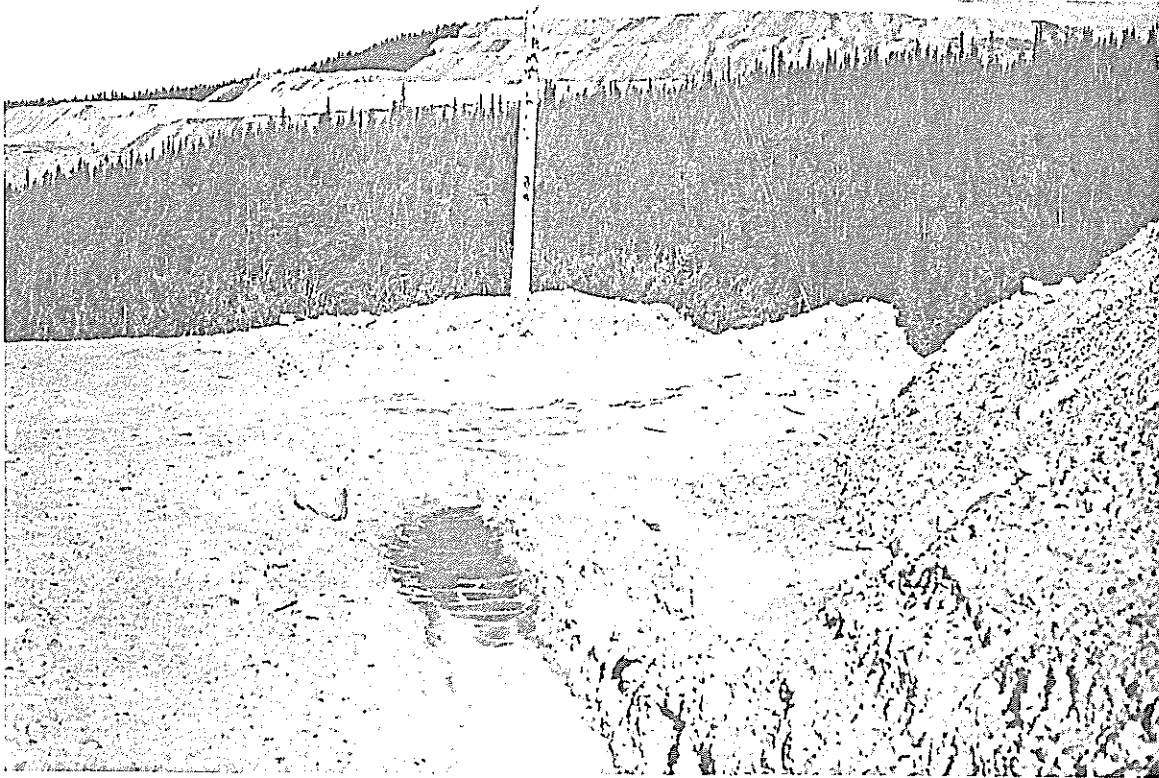


Photo 11 - Ponding of runoff from Little Creek Dam approach road.

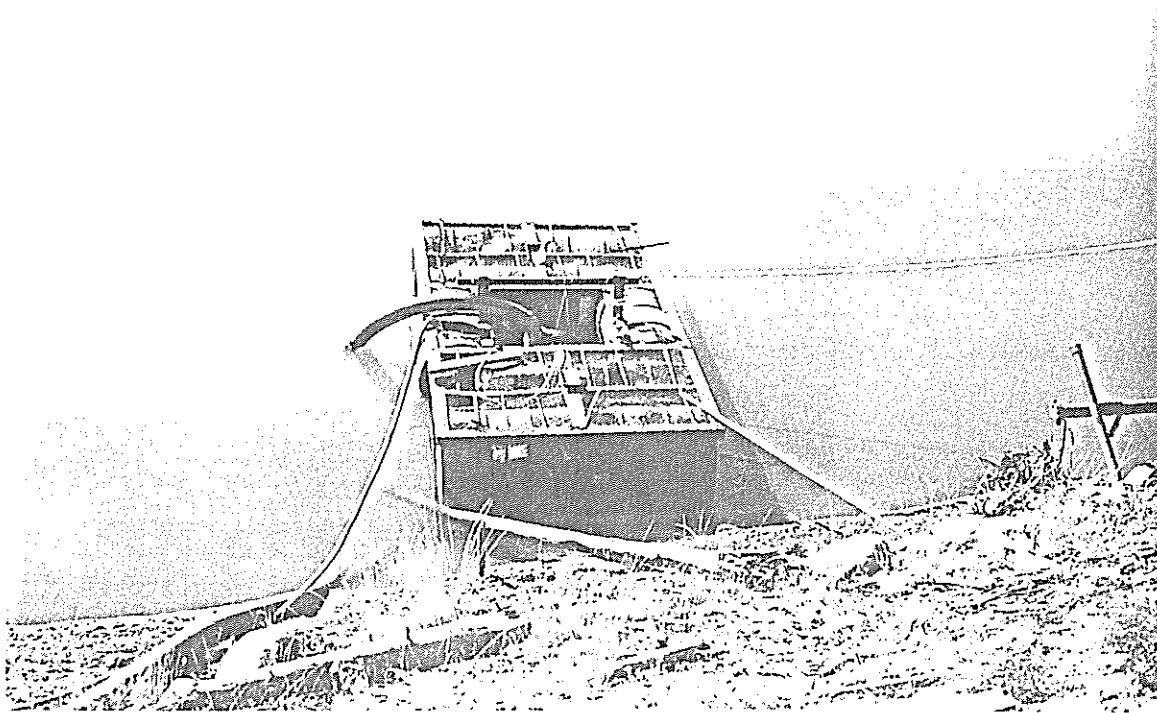


Photo 12 - Pumping system to Vangorda pit.



Photo 13 - Headworks of Vangorda Creek Diversion.

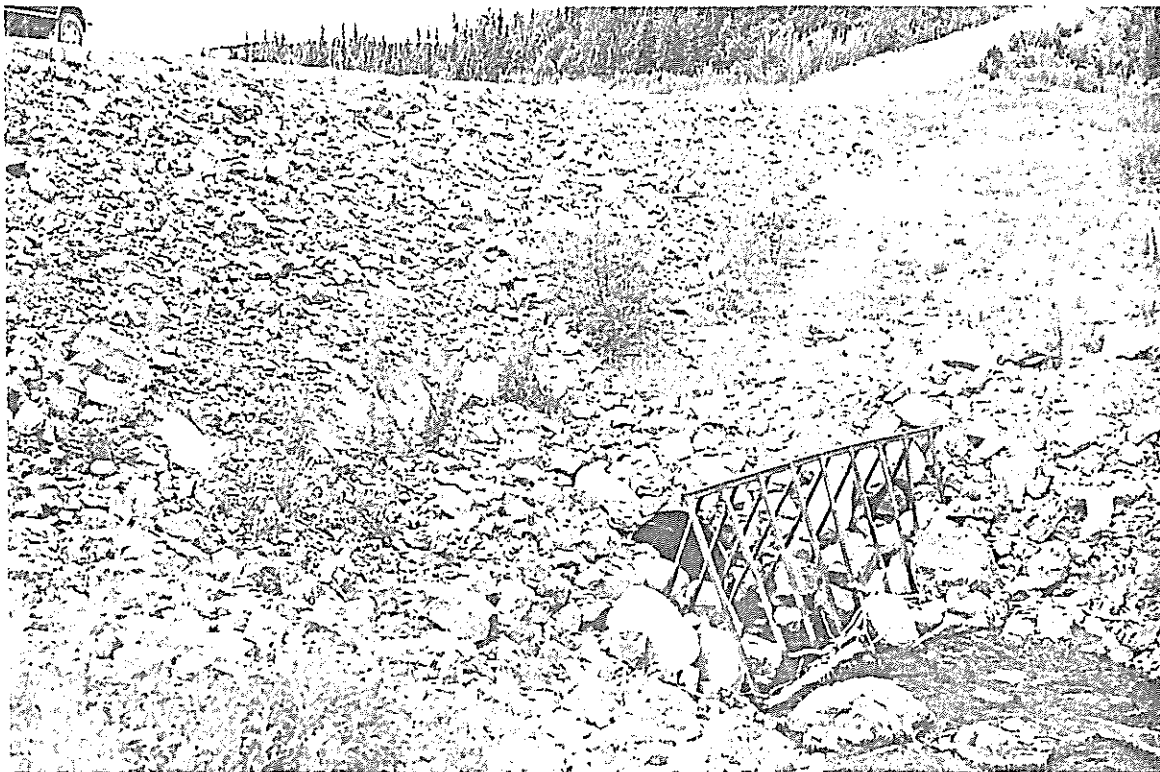


Photo 14 - Inlet to and trash rack at culvert beneath headworks of Vangorda Creek Diversion.

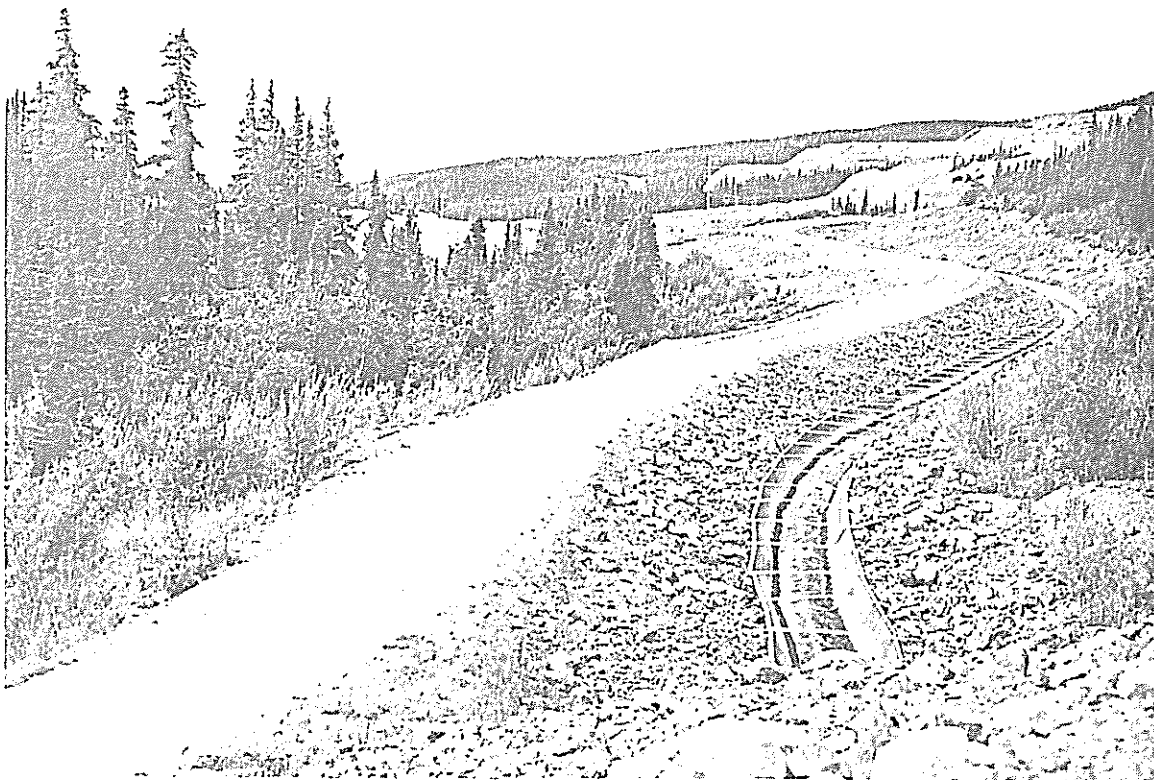


Photo 15 - Upper reaches of Vangorda Creek Diversion.

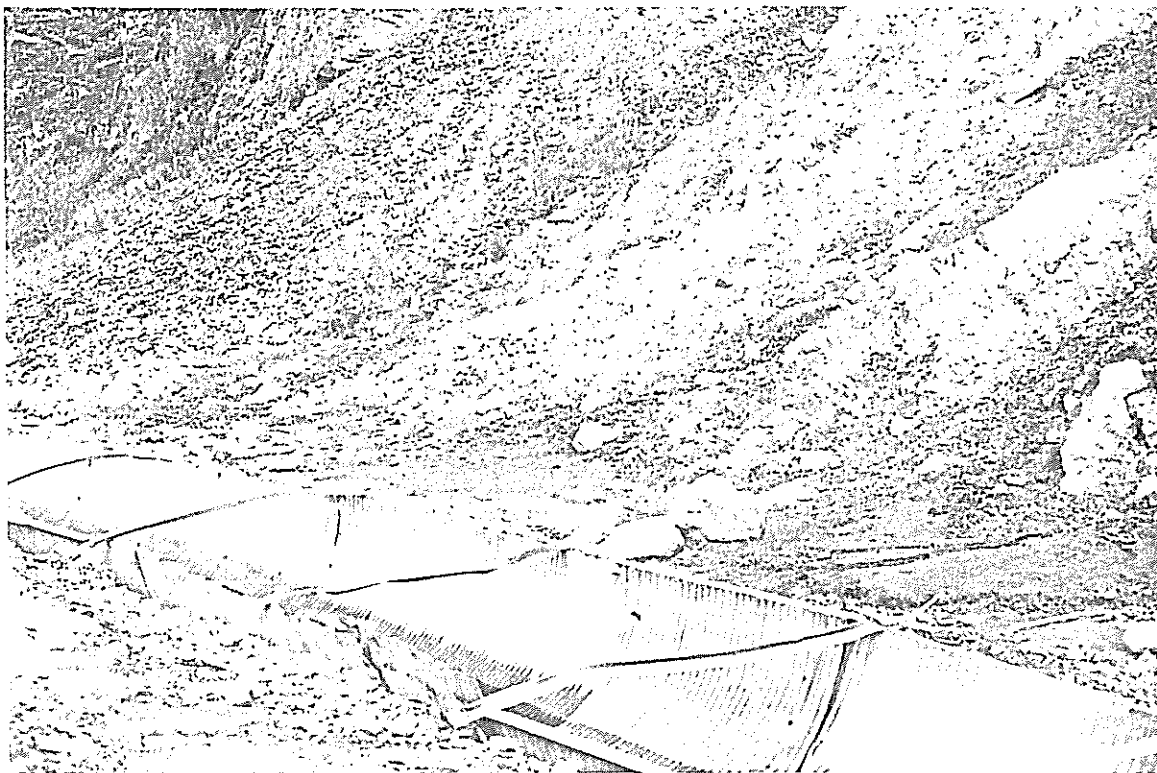


Photo 16 - Subsidence area above lower reaches of Vangorda Creek Diversion.



Photo 17 - Lower reaches of Vangorda Creek Diversion.



Photo 18 - Outlet of Vangorda Creek Diversion and stilling basin.

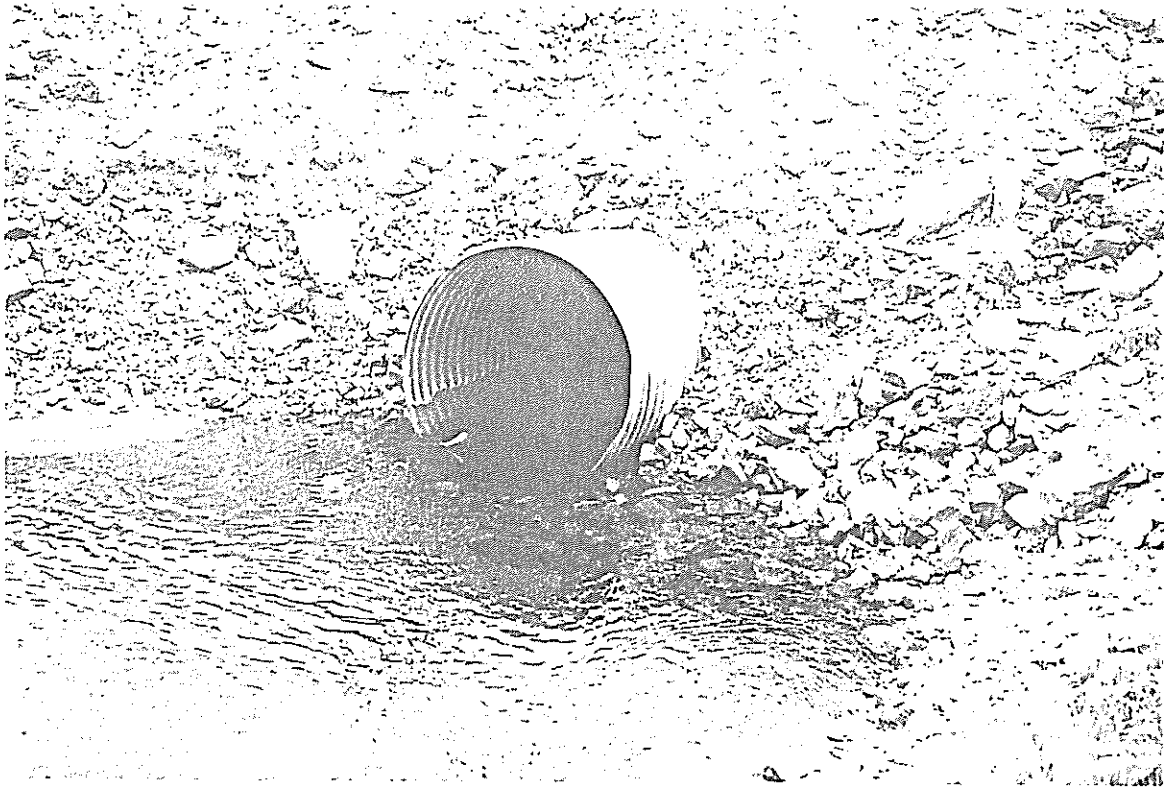


Photo 19 - Inlet to 2m dia. CMP and drop box structure.



Photo 20 - Crest of sludge pond embankment at treatment plant.



Photo 21 - Upper reaches of Grum intercepter ditch.

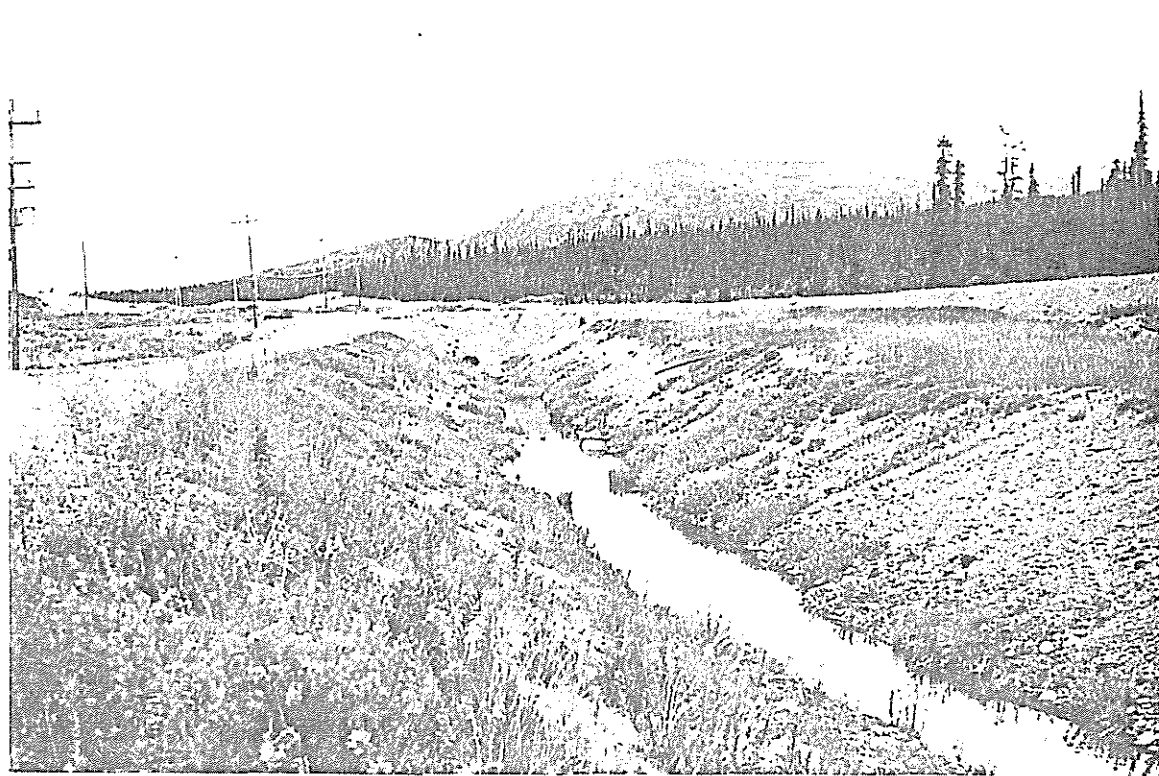


Photo 22 - Middle reach of Grum intercepter ditch.



Photo 23 - Section of Grum Interceptor Ditch Treatment Plant.



Photo 24 - Outlet of damaged culvert adjacent to Sheep Pad Settling Pond.

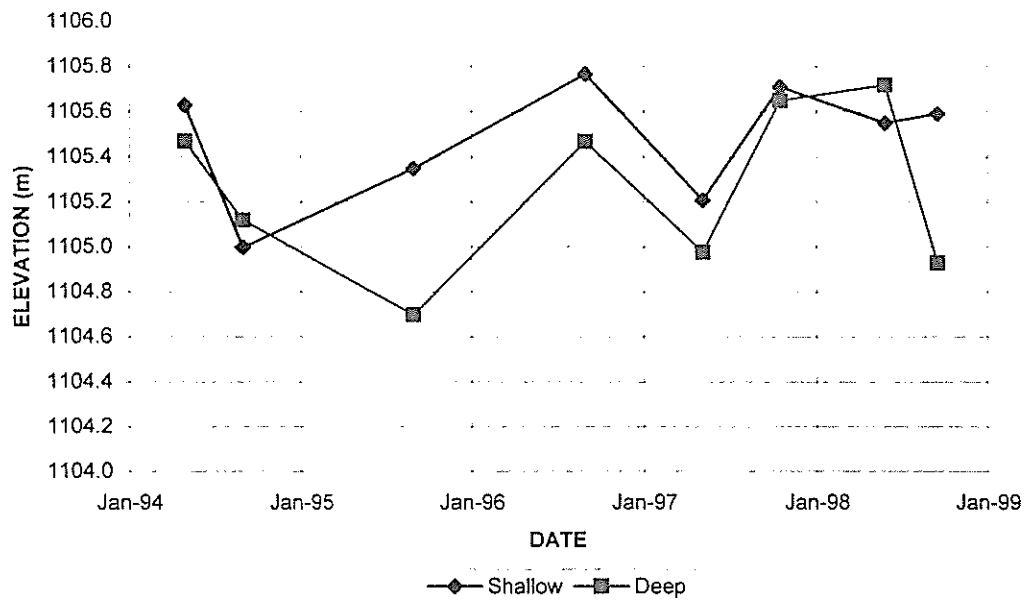
APPENDIX B

**Pneumatic Piezometer and
Thermistor Readings - Little Creek Dam**

Little Creek Dam Pneumatic Piezometers

BH94 LCD1		Location: Little Creek Dam Crest		Ground Elevation: 1114.5m		Coordinates: 3000N, 13460E	
Date Installed: June '94		Shallow Tip Elevation: 1103.6		Surface Deep Tip Elevation : 1097.0		Protector: yes	
Date	Reading (psi)		Piezometric Elevation (m)		Pond Level		
	Shallow	Deep	Shallow	Deep			
May-94	2.9	12.1	1105.63	1105.47			
Sep-94	2.0	11.6	1105.00	1105.12			
Sep-95	2.5	11.0	1105.35	1104.70			
Sep-96	3.1	12.1	1105.77	1105.47			
May-97	2.3	11.4	1105.21	1104.98			
Oct-97	3.02	12.36	1105.71	1105.65			
May-98	2.79	12.46	1105.55	1105.72			
Sep-98	2.85	11.33	1105.60	1104.93	~1109.5		

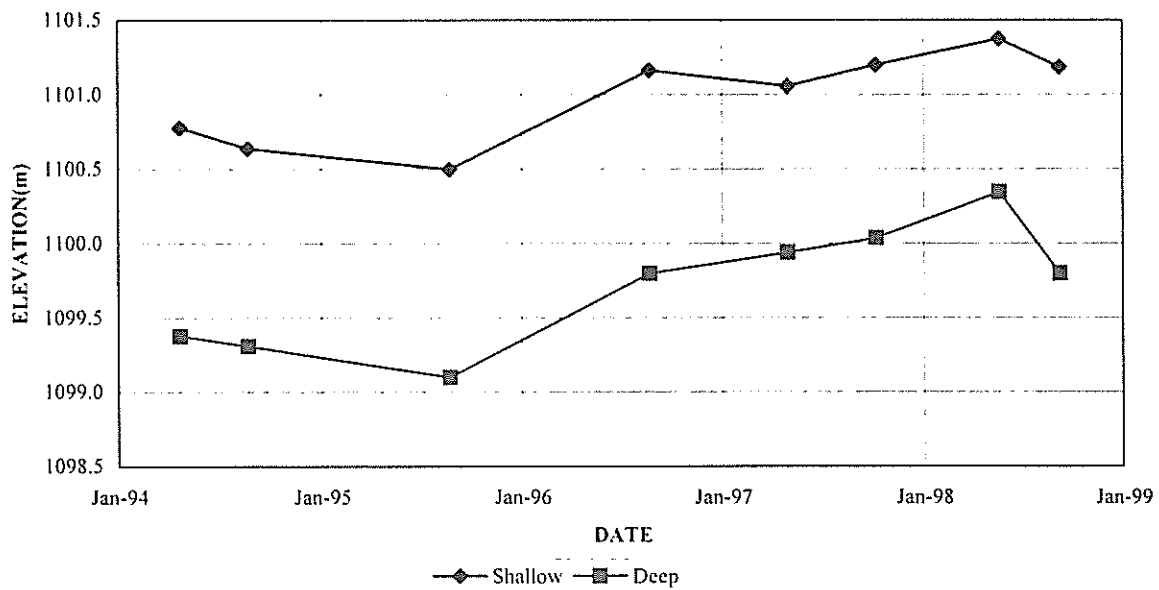
PNEUMATIC PIEZOMETER BH94 LCD1



Little Creek Dam Pneumatic Piezometers

BH94 LCD2		Location: Little Creek Dam Crest		Ground Elevation: 1114.5m	Coordinates: 3065N,13485E	
Date Installed: June '94		Shallow Tip Elevation: 1100.5 Deep Tip Elevation : 1094.9		Surface Protector: yes		
Date	Reading (psi)		Piezometric Elevation (m)		Pond Level	
	Shallow	Deep	Shallow	Deep		
May-94	0.4	6.4	1100.78	1099.38		
Sep-94	0.2	6.3	1100.64	1099.31		
Sep-95	0.0	6.0	1100.50	1099.10		
Sep-96	0.95	7.0	1101.17	1099.80		
May-97	0.8	7.2	1101.06	1099.94		
Oct-97	1.00	7.34	1101.20	1100.04		
May-98	1.25	7.78	1101.38	1100.35		
Sep-98	0.98	7.00	1101.19	1099.80	~1109.5	

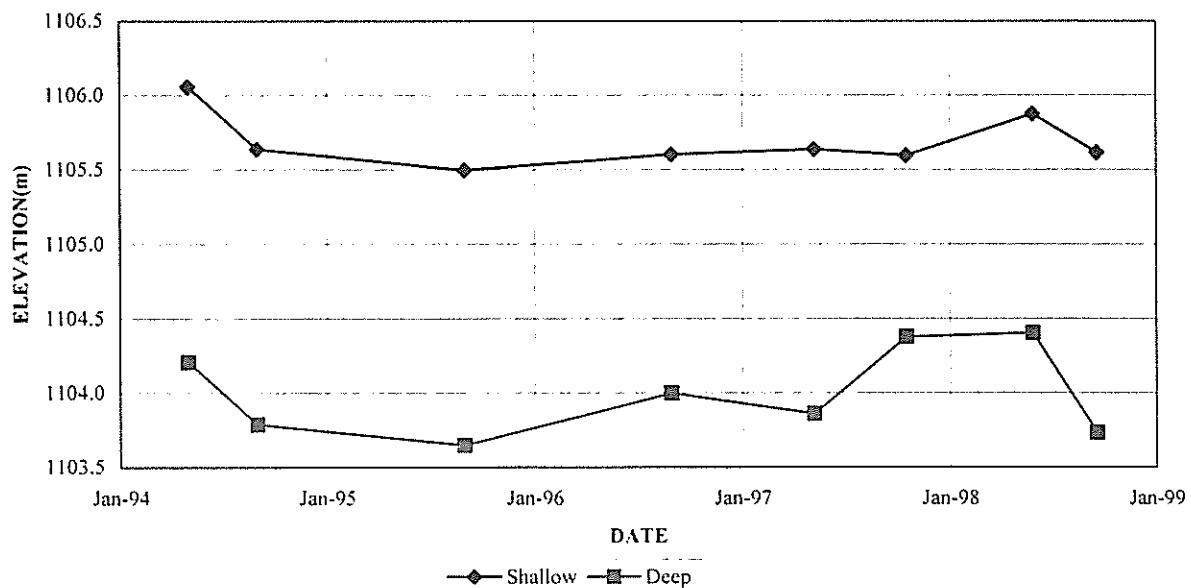
PNEUMATIC PIEZOMETER BH94 LCD2



Little Creek Dam Pneumatic Piezometers

BH94 LCD3		Location: Little Creek Dam Crest	Ground Elevation: 1114.5m	Coordinates: 3115N, 13525E
Date Installed: June '94		Shallow Tip Elevation: 1105.5	Surface Protector: yes	
		Deep Tip Elevation : 1101.2		
Date	Reading (psi)		Piezometric Elevation (m)	
	Shallow	Deep	Shallow	Deep
May-94	0.8	4.3	1106.06	1104.21
Sep-94	0.2	3.7	1105.64	1103.79
Sep-95	0.0	3.5	1105.50	1103.65
Sep-96	0.15	4.0	1105.61	1104.00
May-97	0.2	3.8	1105.64	1103.86
Oct-97	0.14	4.54	1105.60	1104.38
May-98	0.54	4.58	1105.88	1104.41
Sep-98	0.17	3.62	1105.62	1103.73

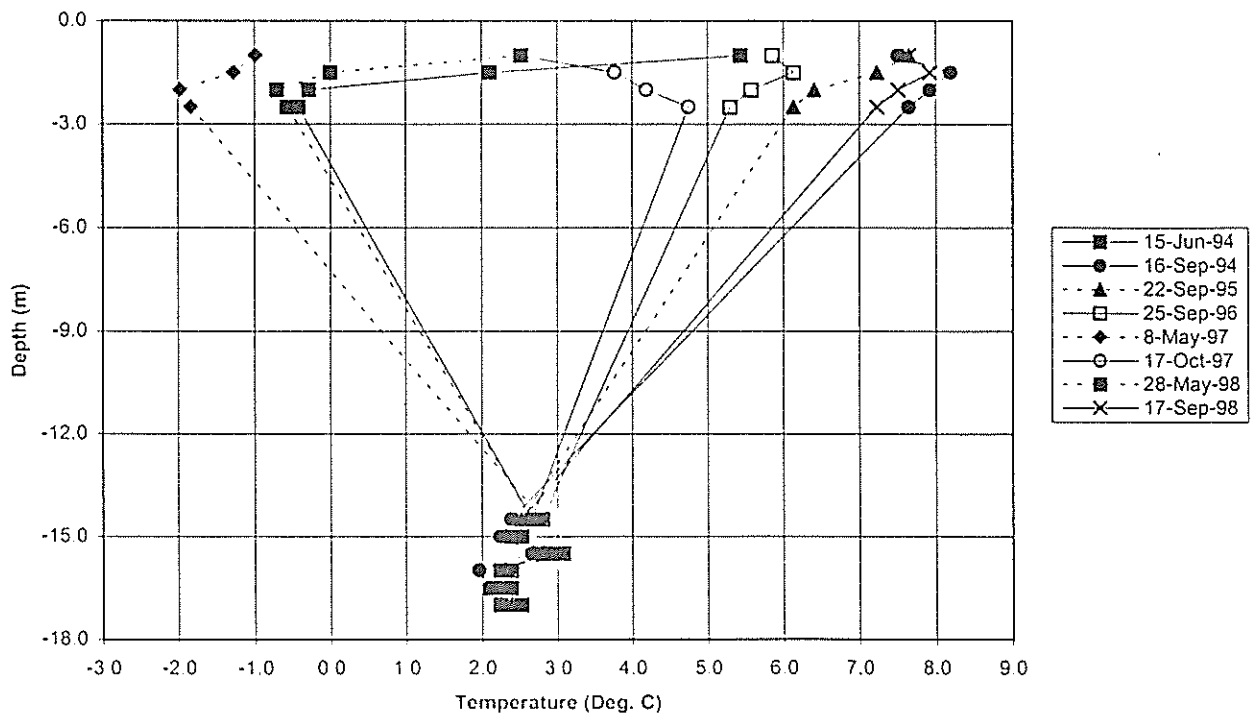
PNEUMATIC PIEZOMETER BH94 LCD3



Little Creek Dam Thermistors

BH94 LCD-4		Location:	Little Creek Dam Crest	Elevation:	1114.5m	Coordinates: 3015N, 13465E				
Date Installed:		8-Jun-94		Thermistor Type:	SINCA RTD's	Ice-Bath Calibration:	not applied	Surface Protector:	yes	
Depth Correction	0			Ro (Ohms)=		1854				
Depth on String (m)	Actual Depth (m)	Resistivity (Ohms) 15-Jun-94	Resistivity (Ohms) 16-Sep-94	Resistivity (Ohms) 22-Sep-95	Resistivity (Ohms) 25-Sep-96	Resistivity (Ohms) 8-May-97	Resistivity (Ohms) 17-Oct-97	Resistivity (Ohms) 28-May-98	Resistivity (Ohms) 17-Sep-98	Resistivity (Ohms)
1.0	-1.0	1893	1908	1909	1896	1847	1872	1872	1909	
1.5	-1.5	1869	1913	1906	1898	1845	1881	1854	1911	
2.0	-2.0	1852	1911	1900	1894	1840	1884	1849	1908	
2.5	-2.5	1851	1909	1898	1892	1841	1888	1850	1906	
14.5	-14.5	1873	1871	1872	1874	1874	1873	1873	1872	
15.0	-15.0	1872	1870	1871	1872	1872	1871	1871	1871	
15.5	-15.5	1874	1873	1875	1876	1876	1875	1875	1875	
16.0	-16.0	1870	1868	1870	1871	1871	1870	1870	1870	
16.5	-16.5	1870	1869	1869	1871	1871	1871	1870	1871	
17.0	-17.0	1870	1870	1871	1872	1872	1872	1872	1871	
Depth on String (m)	Actual Depth (m)	Temperature (C) 15-Jun-94	Temperature (C) 16-Sep-94	Temperature (C) 22-Sep-95	Temperature (C) 25-Sep-96	Temperature (C) 8-May-97	Temperature (C) 17-Oct-97	Temperature (C) 28-May-98	Temperature (C) 17-Sep-98	Temperature (C) 0-Jan-00
1.0	-1.0	5.4	7.5	7.7	5.9	-1.0	2.5	2.5	7.7	
1.5	-1.5	2.1	8.2	7.2	6.1	-1.3	3.8	0.0	7.9	
2.0	-2.0	-0.3	7.9	6.4	5.6	-2.0	4.2	-0.7	7.5	
2.5	-2.5	-0.4	7.7	6.1	5.3	-1.8	4.7	-0.6	7.2	
14.5	-14.5	2.7	2.4	2.5	2.8	2.8	2.7	2.7	2.5	
15.0	-15.0	2.5	2.2	2.4	2.5	2.5	2.4	2.4	2.4	
15.5	-15.5	2.8	2.7	2.9	3.1	3.1	2.9	2.9	2.9	
16.0	-16.0	2.2	2.0	2.2	2.4	2.4	2.2	2.2	2.2	
16.5	-16.5	2.2	2.1	2.1	2.4	2.4	2.4	2.2	2.4	
17.0	-17.0	2.2	2.2	2.4	2.5	2.5	2.5	2.5	2.4	

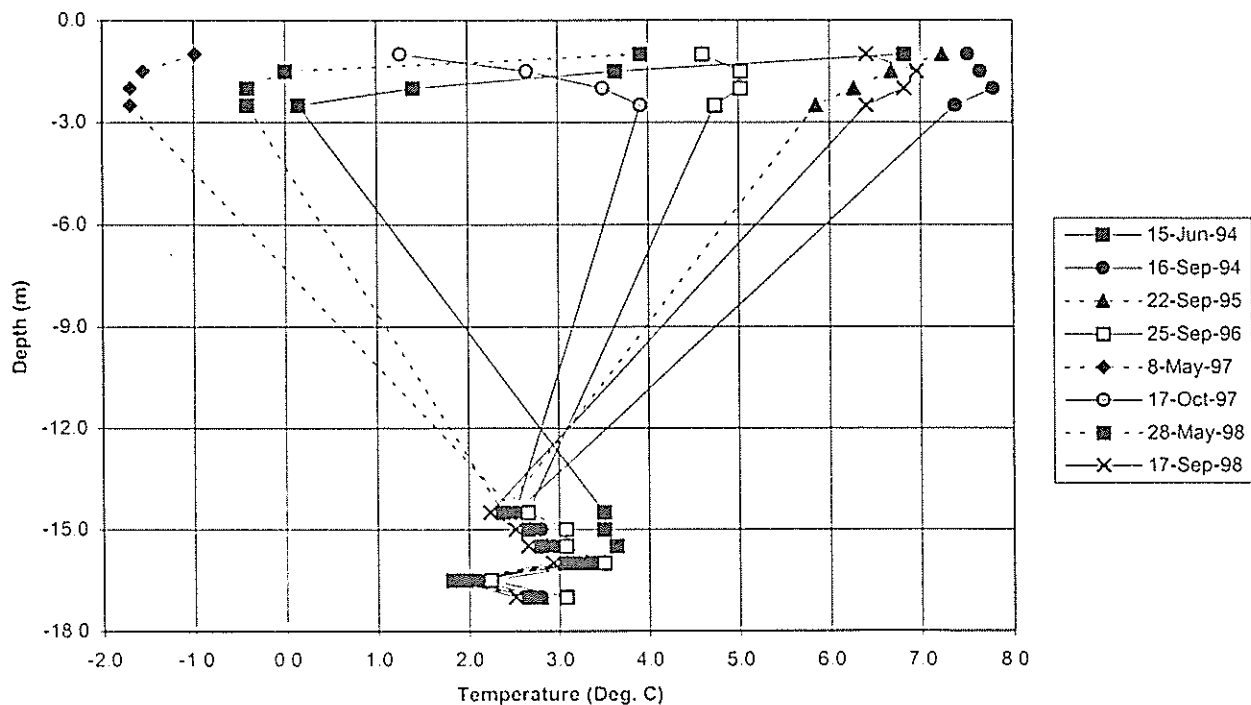
THERMISTOR BH94 LCD-4
(installed 94/06/08)



Little Creek Dam Thermistors

BH94 LCD-5		Location:		Little Creek Dam Crest		Elevation:		1114.5m		Coordinates: 3090N, 13500E	
Date		Thermistor		SINCA		Ice-Bath		Surface			
Installed:		8-Jun-94		Type:		RTD's		Calibration:		not applied	
Protector:		yes									
Depth Correction		0		Ro (Ohms)=		1854					
Depth on String	Actual Depth	Resistivity (Ohms) 15-Jun-94	Resistivity (Ohms) 16-Sep-94	Resistivity (Ohms) 22-Sep-95	Resistivity (Ohms) 25-Sep-96	Resistivity (Ohms) 8-May-97	Resistivity (Ohms) 17-Oct-97	Resistivity (Ohms) 28-May-98	Resistivity (Ohms) 17-Sep-98	Resistivity (Ohms)	
1.0	-1.0	1903	1908	1906	1887	1847	1863	1882	1900		
1.5	-1.5	1880	1909	1902	1890	1843	1873	1854	1904		
2.0	-2.0	1864	1910	1899	1890	1842	1879	1851	1903		
2.5	-2.5	1855	1907	1896	1888	1842	1882	1851	1900		
14.5	-14.5	1879	1872	1871	1873	1872	1872	1871	1870		
15.0	-15.0	1879	1873	1873	1876	1874	1874	1873	1872		
15.5	-15.5	1880	1875	1874	1876	1875	1875	1874	1873		
16.0	-16.0	1878	1876	1877	1879	1877	1877	1876	1875		
16.5	-16.5	1868	1868	1868	1870	1869	1869	1867	1867		
17.0	-17.0	1873	1873	1874	1876	1874	1874	1873	1872		
Depth on String	Actual Depth	Temperature (C) 15-Jun-94	Temperature (C) 16-Sep-94	Temperature (C) 22-Sep-95	Temperature (C) 25-Sep-96	Temperature (C) 8-May-97	Temperature (C) 17-Oct-97	Temperature (C) 28-May-98	Temperature (C) 17-Sep-98	Temperature (C) 0-Jan-00	
1.0	-1.0	6.8	7.5	7.2	4.6	-1.0	1.3	3.9	6.4		
1.5	-1.5	3.6	7.7	6.7	5.0	-1.5	2.7	0.0	7.0		
2.0	-2.0	1.4	7.8	6.3	5.0	-1.7	3.5	-0.4	6.8		
2.5	-2.5	0.1	7.4	5.9	4.7	-1.7	3.9	-0.4	6.4		
14.5	-14.5	3.5	2.5	2.4	2.7	2.5	2.5	2.4	2.2		
15.0	-15.0	3.5	2.7	2.7	3.1	2.8	2.8	2.7	2.5		
15.5	-15.5	3.6	2.9	2.8	3.1	2.9	2.9	2.8	2.7		
16.0	-16.0	3.4	3.1	3.2	3.5	3.2	3.2	3.1	2.9		
16.5	-16.5	2.0	2.0	2.0	2.2	2.1	2.1	1.8	1.8		
17.0	-17.0	2.7	2.7	2.8	3.1	2.8	2.8	2.7	2.5		

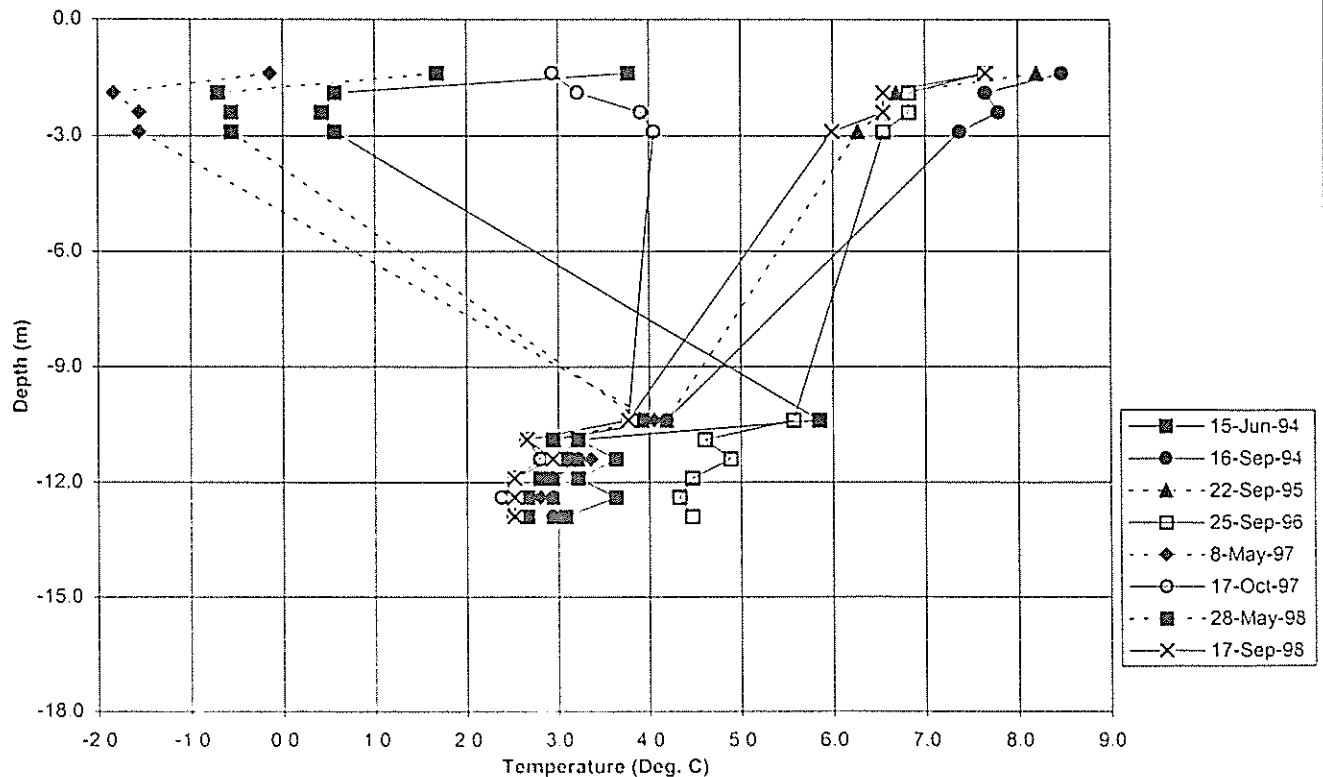
THERMISTOR BH94 LCD-5
(installed 94/06/08)



Little Creek Dam Thermistors

BH94 LCD-6		Location: Little Creek Dam Crest		Elevation: 1114.5m		Coordinates: 3125N, 13535E					
Date Installed:		10-Jun-94		Thermistor Type:		SINCA RTD's		Ice-Bath Calibration: not applied		Surface Protector: yes	
Depth Correction		0.4		Ro (Ohms)=		1854					
Depth on String (m)	Actual Depth (m)	Resistivity (Ohms) 15-Jun-94	Resistivity (Ohms) 16-Sep-94	Resistivity (Ohms) 22-Sep-95	Resistivity (Ohms) 25-Sep-96	Resistivity (Ohms) 8-May-97	Resistivity (Ohms) 17-Oct-97	Resistivity (Ohms) 28-May-98	Resistivity (Ohms) 17-Sep-98	Resistivity (Ohms)	
1.0	-1.4	1881	1915	1913	1909	1853	1875	1866	1909		
1.5	-1.9	1858	1909	1902	1903	1841	1877	1849	1901		
2.0	-2.4	1857	1910	1901	1903	1843	1882	1850	1901		
2.5	-2.9	1858	1907	1899	1901	1843	1883	1850	1897		
10.0	-10.4	1896	1884	1884	1894	1883	1881	1882	1881		
10.5	-10.9	1877	1875	1875	1887	1875	1873	1875	1873		
11.0	-11.4	1880	1877	1877	1889	1878	1874	1876	1875		
11.5	-11.9	1877	1875	1875	1886	1875	1872	1874	1872		
12.0	-12.4	1880	1875	1875	1885	1874	1871	1873	1872		
12.5	-12.9	1876	1875	1875	1886	1875	1872	1873	1872		
Depth on String (m)	Actual Depth (m)	Temperature (C) 15-Jun-94	Temperature (C) 16-Sep-94	Temperature (C) 22-Sep-95	Temperature (C) 25-Sep-96	Temperature (C) 8-May-97	Temperature (C) 17-Oct-97	Temperature (C) 28-May-98	Temperature (C) 17-Sep-98	Temperature (C) 0-Jan-00	
1.0	-1.4	3.8	8.5	8.2	7.7	-0.1	2.9	1.7	7.7		
1.5	-1.9	0.6	7.7	6.7	6.8	-1.8	3.2	-0.7	6.5		
2.0	-2.4	0.4	7.8	6.5	6.8	-1.5	3.9	-0.6	6.5		
2.5	-2.9	0.6	7.4	6.3	6.5	-1.5	4.1	-0.6	6.0		
10.0	-10.4	5.9	4.2	4.2	5.6	4.1	3.8	3.9	3.8		
10.5	-10.9	3.2	2.9	2.9	4.6	2.9	2.7	2.9	2.7		
11.0	-11.4	3.6	3.2	3.2	4.9	3.4	2.8	3.1	2.9		
11.5	-11.9	3.2	2.9	2.9	4.5	2.9	2.5	2.8	2.5		
12.0	-12.4	3.6	2.9	2.9	4.3	2.8	2.4	2.7	2.5		
12.5	-12.9	3.1	2.9	2.9	4.5	2.9	2.5	2.7	2.5		

THERMISTOR BH94 LCD-6
(installed 94/06/10)



APPENDIX 4
1998 TECHNICAL ADVISORY COMMITTEE MEETING
AGENDAS, ATTENDEES, MINUTES



Postal Bag 1000, Faro, Yukon Y0B 1K0
Phone (867) 994-2459 or (867) 994-3057
Facsimile (867) 994-3483 or (867) 994-3057
E-Mail anvilfa@yknet.yk.ca

FAX MESSAGE TO: distribution attached

DATE: June 8, 1998

FROM: Eric Denholm, Environmental Engineer

RE: Next Technical Advisory Committee Meeting

MESSAGE: Please let me know about attending the next T.A.C. meeting which I have scheduled for June 25th in Faro. Accommodations in Faro are limited to Sally's Roadhouse and Redmond's Hotel although other arrangements may be possible in special circumstances.

Holding the meeting in Faro will allow the group to observe first hand the environmental work underway at the minesite.

Regards,

RETURN FAX TO: Eric Denholm, 994-3057 or 994-3483

FROM: _____

MESSAGE: I will attend: _____

I will not attend: _____

Additional items for the agenda or comments:

ANVIL RANGE MINING CORPORATION (Interim Receivership)
TECHNICAL ADVISORY COMMITTEE MEETING
(PRELIMINARY CIRCULAR)

DATE: Thursday June 25, 1998; 9:00 am to 4:00 pm

LOCATION: Faro, guest house, large house, 248 Dawson, lower bench

PROPOSED AGENDA:

1. BRIEF OVERVIEW OF: SITE MANAGEMENT
1998 ENVIRONMENTAL WORK
LICENCE COMPLIANCE
2. SITE TOUR: FARO MAIN/ZONE II PITS
MILL/LIME MIXING
DOWN VALLEY/TAILINGS
VANGORDA PLATEAU
4. ICAP: REVIEW OF CLOSURE PLAN

DISTRIBUTION: Access Mining Consultants Ltd.: Gregg Jilson 667-6680
Deloitte & Touche: Doug Sedgwick (905) 803-5101
Deloitte and Touche: Greg Stevens (403) 263-2390
Deloitte and Touche: John Whitehead (Faro)
Dept. of Fisheries and Oceans: Gail Faulkner 393-6738
DIAND, Environment: Kirstie Simpson 667-3216
DIAND, Land Use: Marion DeJean 667-3193
DIAND, Mineral Resources: Martin Barnett (819)953-9066
DIAND, Mineral Resources: Allen Waroway 667-3193
DIAND, Water Resources: Dave Sherstone 667-3195
Environment Canada: Vic Enns, Eric Soprovitch 667-7962
Ross River Dena Council: George Smith 969-2405
Selkirk First Nation: Don Trudeau 537-3902
Town of Faro, Jim McLaughlin (Faro)
Yukon Conservation Society: Bob Van Dijken 668-6637
YTG, Economic Development: Jesse Duke 667-8601
YTG, Renewable Resources: Chuck Hubert 667-3641

VANGORDA PLATEAU TECHNICAL ADVISORY COMMITTEE

SUMMARY OF MEETING JUNE 25, 1998

Location: Faro

<u>Attendees:</u>	Access Mining Consultants Ltd., Gregg Jilson	667-6680
	Deloitte and Touche, Eric Denholm (chair)	
	Deloitte and Touche, Dana Haggar	
	Deloitte and Touche, Mike Bryson	
	DIAND, Environment, Kirstie Simpson	667-3216
	DIAND, Mining Land Use, Marion Dejean	667-3193
	DIAND, Mineral Resources, Allan Carlick	667-3193
	DIAND, Mineral Resources, Mark Langdon	667-3193
	DIAND, Mining Development, Hugh Copeland	667-3193
	DIAND, Water Resources, Bud McAlpine	667-3195
	DIAND, Water Resources, Milos Stepanich	667-3195
	Environment Canada, Eric Soprovitch	667-7962
	Environment Canada, Allison Back	667-7962
	Ross River Dena Council, George Smith	969-2405
	Selkirk First Nation, Don Trudeau	537-3902
	Town of Faro, Jim McLaughlin	
	Town of Faro, Jen Meurer	
	Yukon Conservation Society, Sue Moodie	668-6637
	Yukon Conservation Society, Lisa Sumi	668-6637
	YTG, Economic Development, Rod Hill	667-8601
	YTG, Renewable Resources, Jon Bowen	667-3641

The meeting was called to order at 9:15 am.

- Eric Denholm provided an overview of changes in site management during 1998; specifically, the court appointment of Deloitte and Touche Inc. (D&T) as interim receiver and their commitment to diligent environmental management.
 - The court had recently (June 21, 1998) approved D&T's management budget which includes allowances for routine water quality monitoring per the Licences, professional geotechnical and biological monitoring per the Licences, required environmental work such as pumping from the Faro Main pit and on-site management personnel; the approved plan also allows for the sale of some equipment which is deemed not to have a negative effect on the opportunities for re-starting the mine; some reagents (incl. all sodium cyanide) have been sold in order to reduce the environmental liabilities.
 - An on-going source of funding for the required on-going environmental work beyond the extent of the currently available money has not yet been identified; however, the
-

currently available money is expected to be adequate to fund the work for approximately one year.

- It was intended that Mr. John Whitehead of D&T would be in Faro to attend this meeting; however, he was unexpectedly called back to Toronto and left Faro early this morning (June 25). Nonetheless, Mr. Doug Sedgwick, D&T Director, Environmental Services was scheduled to speak to the meeting at the end of the day from Ontario via the speakerphone.
- Eric Denholm gave a description of the environmental work currently underway or recently undertaken and briefly talked through each of the handouts (5, attached); the importance of the Faro Main pit filling curve was stressed as pumping and treating water from the pit represents the largest project underway; the dewatering of the pit is currently ahead of plan.
- Milos Stepanich inquired re. the continuance of geotechnical monitoring on the Faro and Vangorda Plateau sites; Eric Denholm responded that the geotechnical instrumentation on both sites had been monitored for the spring '98 program and was scheduled to be monitored again for the fall '98 program as per the established routine.
- Eric Denholm presented an overview of compliance issues and stated that, in general, compliance with the Licences continues to be excellent; the required annual reports were late to be filed this year as a result of the turmoil at the minesite.
- As of June 19, effluent discharge had been stopped while investigations were underway into unexpectedly high reported concentrations of total cyanide and the Faro pit pumping system was also temporarily shut down for this investigation; the preliminary indication from the investigation was that the reported high cyanide concentrations were the result of laboratory error and that there was not actually any measurable cyanide in the water; nonetheless, discharge would not be re-started until confirmation had been obtained and consultation with DIAND, Water Resources had been undertaken (Ed. note: the preliminary indication of lab. error was subsequently confirmed and discharge was resumed on June 26).
- Don Trudeau inquired whether the final environmental report re. the high reported cyanide concentrations could be distributed and Eric Denholm replied that the report would be attached to the TAC meeting summary (Ed. note: the final env. report is attached here).
- A brief discussion of reclamation tasks and priorities was held and Eric Denholm indicated that, in his view, the primary obstacle preventing the undertaking of reclamation/closure work was the availability of funding. Bud McAlpine stated that the Reclamation Security Agreement contains requirements which must be met prior to the release of any money.

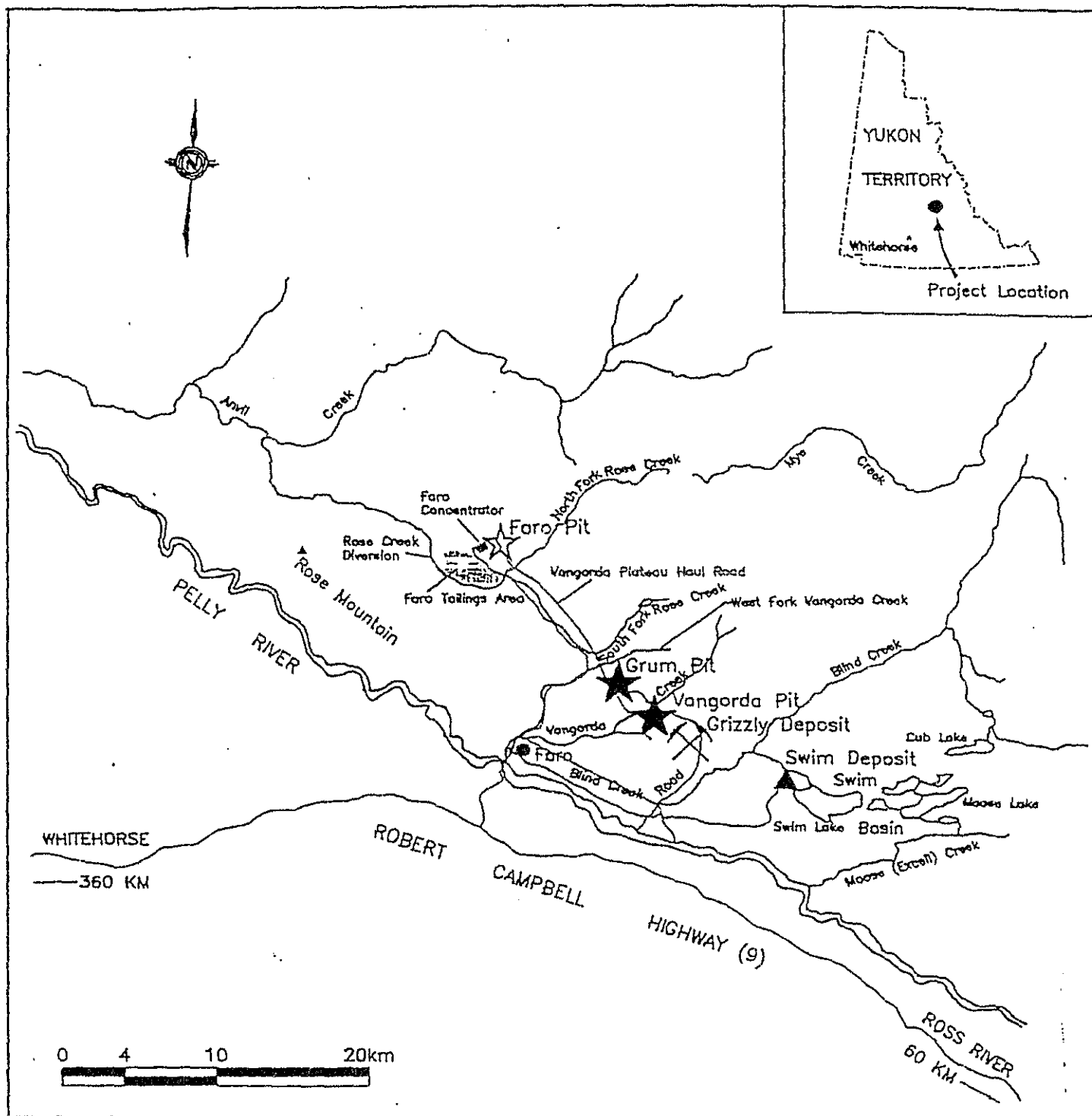
- Milos Stepanich proposed that the Freshwater dam could be a candidate for reclamation work since the mill now operates primarily on water recycled from the Faro Main pit and because the dam is known to have cracking along the crest; Dana Haggart confirmed that the mill had operated successfully on primarily (est. >95%) recycle water; Eric Denholm added that there may be some benefit to leaving the dam in place as an operational contingency for future mine operators.
- George Smith inquired re. the status of the Ross River scholarship fund and Eric Denholm replied that he was unable to respond to this matter but would pass the inquiry on to the appropriate D&T personnel.
- a tour of the minesites was taken with stops and discussions at the following locations:
 1. Faro Main pit pumping installation
 2. Down Valley; south abutment of Intermediate dam
 3. Grum pit viewpoint
 4. Vangorda pit/Little Creek dam viewpoint
 5. Grum/Vangorda water treatment plant
- Following the tour, attempts were made to contact Mr. Doug Sedgwick as planned but access could not be attained via the cell phone; requests were made that business card information be made available for Mr. Sedgwick; Eric Denholm replied that this would be attached to the meeting summary and business cards for Mr. John Whitehead were given to those interested (contact info. re. Mr. Sedgwick provided below).

The meeting was adjourned at 4:00pm.

distribution: all attendees
Doug Sedgwick, Deloitte and Touche, Mississauga
Dave Sherstone, DIAND, Water Resources
Brian Ferguson, DFO, Whitehorse

Douglas Sedgwick, Director, Environmental Services
Deloitte and Touche
1 City Centre Drive, Suite 1100
Mississauga, Ontario, L5B 1M2

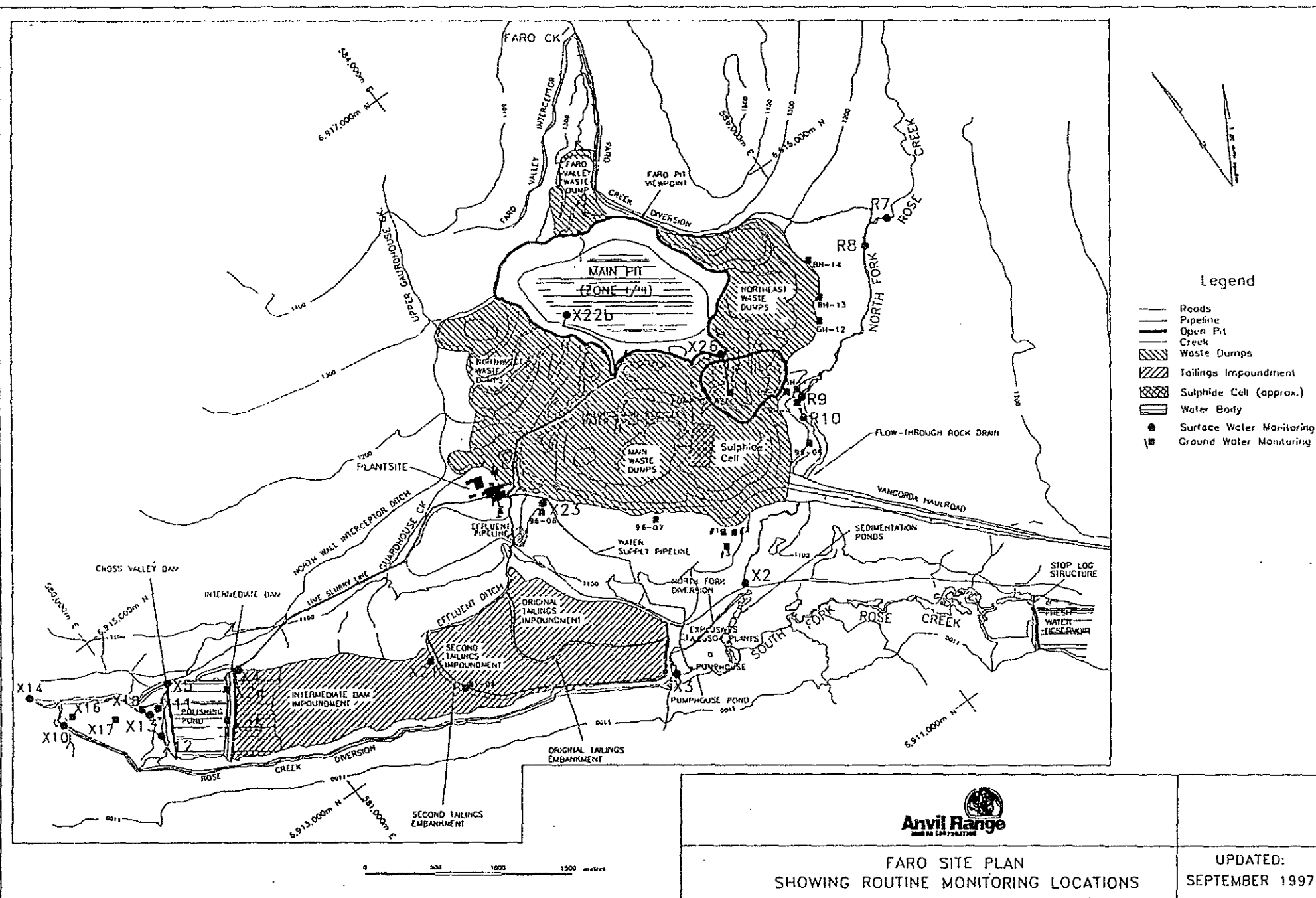
Direct Line: (905) 803-5134
Facsimile: (905) 803-5101
Internet: dsedgwick@deloitte.ca1



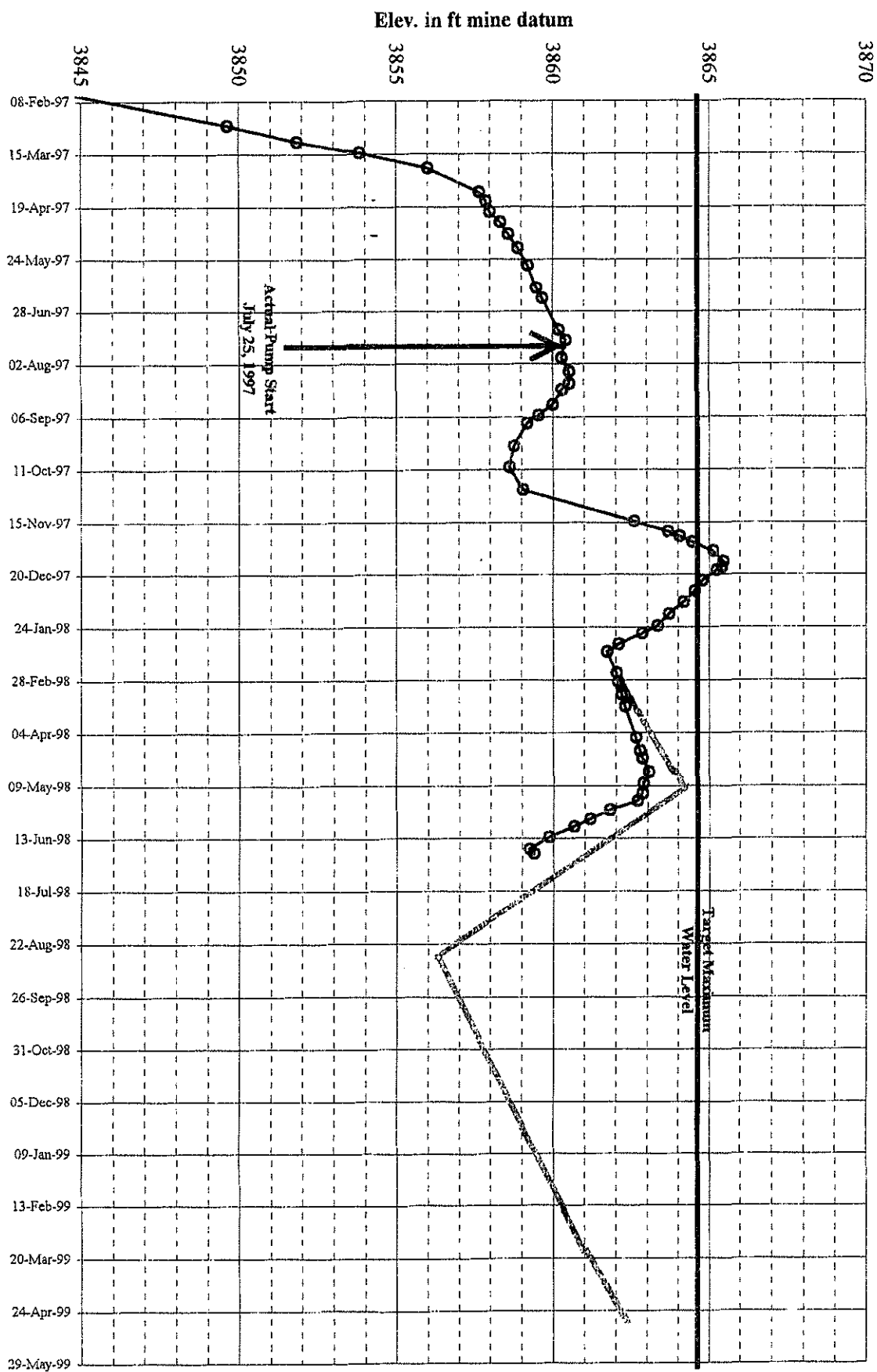
FARO OPERATIONS REGIONAL PLAN

UPDATED: OCTOBER 1996





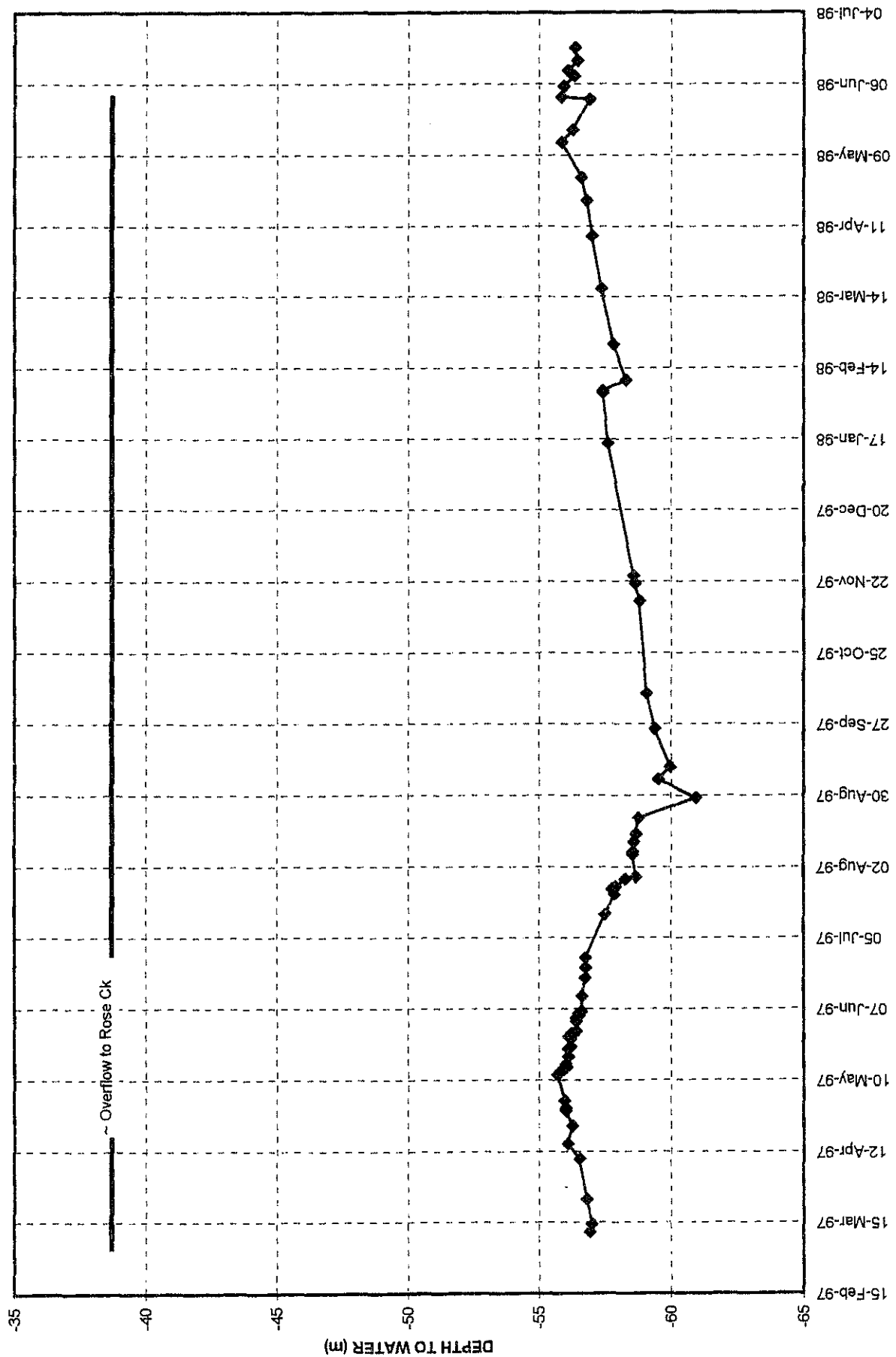
Faro Pit Water Level Projection Dewatering from May to August 1998



UTM = Mine datum - 109.6 ft
Overflow to Zone II pit @ -3909.6 ft mine datum

Printed: 24/06/98

WATER LEVEL IN THE FARO ZONE II PIT



Depth Monitoring began March 1997.

VANGORDA ROCK DUMP LEGEND

DRAIN #1 = V28

DRAIN #2 = V29

DRAIN #3 = V30

DRAIN #4 = V31

DRAIN #5 = V32

DRAIN #6 = V33

GROUNDWATER WELLS = V34 TO V38

PIEZOS. IN TOE BERM = V39 TO V47

LEGEND

— Creek or Ditch

— Pipeline

— Rock Dump or Road

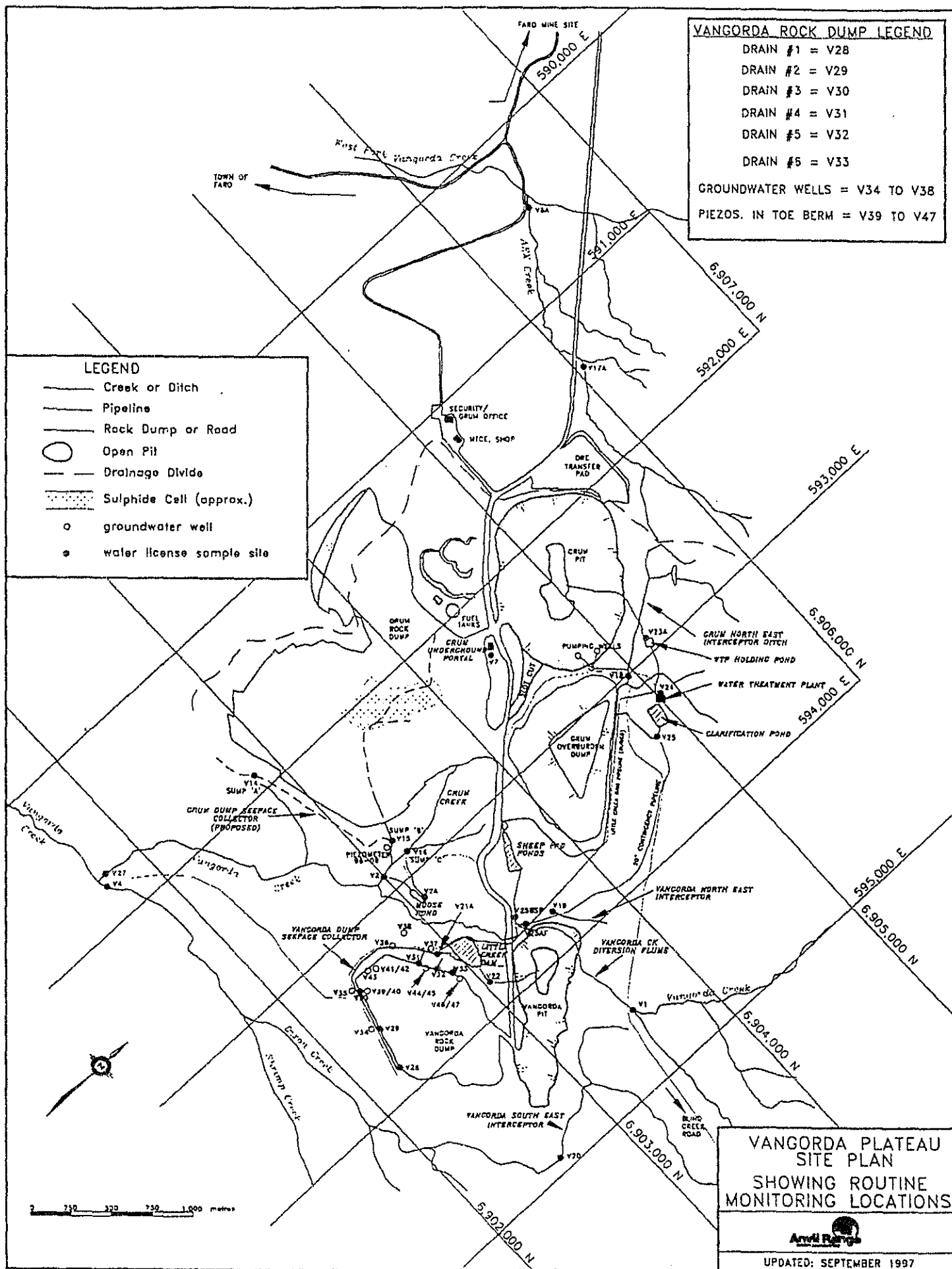
○ Open Pit

— Drainage Divide

▨ Sulphide Cell (approx.)

○ groundwater well

● water license sample site



VANGORDA PLATEAU
SITE PLAN
SHOWING ROUTINE
MONITORING LOCATIONS



UPDATED: SEPTEMBER 1997



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Facsimile (867) 994-3483
E-Mail anvilfa@yknet.yk.ca

ENVIRONMENTAL REPORT RE. FALSELY REPORTED EFFLUENT CYANIDE CONCENTRATIONS

Prepared July 6, 1998

SUMMARY

Routine analytical results were received on June 15 which indicated that a discharge had taken place of effluent containing total cyanide greater than the maximum allowable discharge limit. A contingency action plan was initiated which included the following tasks:

1. follow up sampling and analyses on a rush basis,
2. notification to appropriate regulatory and "in-house" personnel,
3. cessation of effluent discharge to the environment,
4. investigation and consultation with expert consultants.

Investigations showed that laboratory error was the cause of the reported high concentrations of total cyanide and that the effluent cyanide concentrations were actually very low and well below the maximum allowable discharge limit.

Effluent discharge was resumed on June 26th following consultation with DIAND, Water Resources that this was appropriate.

The laboratory protocol has been altered to reduce the chances of a recurrence.

DESCRIPTION

Discharge of treated effluent from the Cross Valley pond into Rose Creek was continuous from April 21 through June 19 and included (beginning May 1) lime treated water from the Faro Main pit. Analyses of the concentration of total cyanide in the effluent are routinely performed on a monthly basis. The concentrations of total cyanide in the effluent prior to May 1998 were typically very low at or near the method detection limit.

However, the analytical results for samples collected on May 18, 1998 indicated an effluent concentration of 1.68 mg/L total cyanide which is well in excess of the maximum allowable discharge limit of 0.05 mg/L total cyanide. The concentration of total cyanide in the receiving water (Rose Creek) immediately downstream of the effluent mixing zone was reported as 0.08 mg/L for the May 18 sample.

Upon receipt of the analytical results for the May 18 samples on June 15, follow up samples were collected and shipped to the regularly utilized external analytical laboratory in Vancouver for rush analyses.

Notification of the elevated concentrations of total cyanide was made to DIAND Water Resources, Deloitte and Touche supervisory staff and Faro staff.

Mr. Tony Polych of DIAND Water Resources visited the minesite on June 19 and collected water samples which were also collected in duplicate by Mr. Eric Denholm of Deloitte and Touche.

The results of the rush analyses on the follow up samples which were collected on June 15 were received on June 19 and indicated an effluent concentration of total cyanide of 4.09 mg/L which was greater than the result reported for May 18. The attached contingency action plan was immediately implemented and the Yukon 24 hour spills line was notified.

Temporary, partial blockages of the Intermediate and Cross Valley dam spillways were installed which successfully stopped the discharge of effluent into Rose Creek. The partial blockages were constructed by a front end loader of uncompacted, loose soil which was locally available.

A detailed program for monitoring changes in the water levels above the dams and changes in seepage from the dams was immediately implemented. Additionally, Golder Associates Ltd. (geotechnical consultant to Deloitte and Touche) were notified of the partial spillway blockages. The water levels in the Cross Valley and Intermediate ponds were observed to increase by 6.0cm and 2.0cm, respectively, during the period while the temporary partial blockages were in place (7 days).

A series of water samples which were collected on June 20 were analysed at a minesite laboratory at a minesite in the Yukon which performs on-site cyanide analyses on a routine basis. The analyses at the minesite lab were intended to be a means of cross checking the results received to date and a means of quickly beginning the investigation into possible sources of cyanide.

The results received from the on-site laboratory did not, however, confirm the results previously received. The results from the minesite lab were much lower than those previously received and indicated that the effluent discharge was in compliance with the maximum allowable discharge limit.

Further results were received on June 24, 25 and 26 for samples analysed in duplicate at three professional laboratories. The analyses included results for the duplicate samples collected with DIAND, Water Resources on June 19. All of the laboratories reported very low WAD (weak acid dissociable) cyanide. However, the routinely used external laboratory was the only one to report elevated concentrations of total cyanide. The results obtained by DIAND, Water Resources were verbally forwarded as being very low.

Following final consultation with DIAND, Water Resources, the partial blockages in the Intermediate and Cross Valley dam spillways were breached on June 26 and effluent discharge was resumed.

Investigations into the laboratory procedures for analysis of cyanide indicated that the complexity of cyanide compounds and the volatile nature of water chemistry can result in the formation of interfering compounds which result in an artificially high cyanide analysis in some circumstances. This was deemed to be the root cause of the falsely reported concentrations of total cyanide.

The laboratory protocol for cyanide analyses has been altered in order to increase confidence that the reported concentrations will be as precise as possible. Beginning on June 29 and carrying on until further notice, cyanide analyses will be sub-contracted by the routine laboratory to a different professional laboratory as selected by Deloitte and Touche.

The analytical results relevant to this report are attached.

FOLLOW UP ACTIONS

The laboratory protocol for analysis of cyanide has been altered to increase confidence in the precision of the reported results.

Routine sampling and analysis for total cyanide will continue as required by the Water Licence or by best management planning.

Eric Denholm, Environmental Engineer

distribution: Tony Polyck, DIAND, Water Resources
Doug Sedgwick, Deloitte and Touche, Toronto
Greg Stevens, Deloitte and Touche, Calgary
John Whitehead, Deloitte and Touche, Toronto
Dan Desjardins, Anvil Range Mining Corporation, Toronto
Faro staff
attachment to June 25, 1998 T.A.C. meeting summary

RELEVANT ANALYTICAL RESULTS

DATE	LOCATION	ROUTINE LAB	MINESITE LAB	ALTERNATE LAB	DIAND LAB
Jan 5/98	X4	<0.01 _t			
	X5	<0.01 _t			
	X13	<0.01 _t			
Jan 12/98	X4	<0.01 _t			
	X5	<0.01 _t			
	X13	<0.01 _t			
Feb 24/98	X4	<0.01 _t			
	X5	No Discharge			
	X13	<0.01 _t			
Mar 17/98	X4	<0.01 _t			
Apr 13/98	X4	<0.01 _t			
	X5	<0.01 _t (no discharge)			
	X13	<0.01 _t			
May 18/98	X4	1.08 _t			
	X5	1.68 _t			
	X13	<0.01 _t			
	X14	0.08 _t			
Jun 15/98	X4	4.09 _t			
	X5	2.38 _t			
	X13	<0.01 _t			
	X14	0.19 _t			
Jun19/98	X4			<0.01 _{t&w}	"acceptable"
	X5			<0.01 _{t&w}	"acceptable"
	X14			0.01 _t / _{<0.01_w}	
June 20/98	X4	2.08 _t / _{<0.01_w}	0.0	0.01 _t / _{<0.01_w}	
	X5	1.34 _t / _{<0.01_w}	0.03	0.01 _t / _{<0.01_w}	
	X14	<0.01 _t / _{<0.01_w}	0.02	0.02 _t / _{<0.01_w}	
Jun 21/98	X4	1.99 _t / _{<0.01_w}		0.01 _t / _{<0.01_w}	
	X5	1.32 _t / _{<0.01_w}		0.09 _t / _{<0.01_w}	
	X14	<0.01 _t		0.01 _t / _{<0.01_w}	
Jun 30/98	X4, X5, X13	pending			

NOTES: "X4" is outflow from the Intermediate pond
 "X5" is effluent discharge as outflow from the Cross Valley pond
 "X13" is combined seepage from the Cross Valley pond
 "X14" is receiving water below effluent mixing zone
 subscripts "t"=total; "w"=weak acid dissociable
 all concentrations as mg/L



Box 1000, Faro, Yukon Y0B 1K0
Phone (867) 994-2459
Fax (867) 994-3483
E-mail anvilfa@yknet.yk.ca

CONTINGENCY ACTION PLAN RE.
NON-COMPLIANT DISCHARGE TO ROSE CREEK
(Prepared June 21, 1998)

1. cease pumping from the Faro pit (remove primary inflow into the Intermediate and Cross Valley ponds)
status: complete 6:00pm June 19
2. install partial temporary blockage of the Cross Valley and Intermediate dam spillways (i.e. step discharge to truck)
status: complete 9:30pm June 19
3. install a temporary pumping system to pump water from the Cross Valley pond into the Intermediate pond (reduce pressure on Cross Valley dam)
status: underway; ready June 22
4. consult with Golder Associates re. blockage of the spillways
status: complete June 20
5. notify all appropriate persons and agencies of current status
status: complete June 19
6. secure a rush supply of hydrogen peroxide as soon as possible (potential treatment)
status: underway
7. sample frequently for total cyanide at key locations as appropriate
status: underway
8. monitor water levels and seepage carefully re. the Cross Valley and Intermediate dams
status: underway
9. re-assess the action plan daily and modify as appropriate
10. notify all appropriate persons and agencies of current status on an on-going basis
11. remove blockage of Cross Valley dam spillway as soon as possible based on acceptable water quality which allows for the resumption of effluent discharge or based on critical geotechnical concerns

APPENDIX 5

LITTLE CREEK POND
EMERGENCY SPILLWAY
VANGORDA MINE
YUKON TERRITORY

Report No. 1CD003.01

STEFFEN ROBERTSON AND KIRSTEN INC.
DECEMBER 1998

1CD003.01

**LITTLE CREEK POND
EMERGENCY SPILLWAY
VANGORDA MINE
YUKON TERRITORY**

Prepared for:

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**LITTLE CREEK POND
EMERGENCY SPILLWAY
VANGORDA MINE
YUKON TERRITORY**

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**LITTLE CREEK POND
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1. Introduction

In August 1998, Steffen Robertson and Kirsten (Canada) Inc (SRK) was retained by Deloitte and Touche to design and manage the construction of an emergency spillway for the Little Creek dam at the Vangorda/Faro Mine, Yukon Territory. The location of the mine is shown on Figure 1 and a site plan of the Little Creek dam is presented on Figure 2.

SRK was asked to review the hydrology of the site, develop a water balance for the Little Creek seepage collection pond, prepare design recommendations for the spillway and prepare construction drawings and technical specifications. A plan of the spillway is shown on Figure 3.

As construction of the spillway was fast tracked, SRK did not prepare a detailed design report prior to construction. An on site meeting was held on August 25, 1998 between SRK, Deloitte and Touche Inc. (DTI) and DIAND. The general specifications of the spillway were agreed to at that meeting. Following the meeting, SRK in association with Pat Bryan (Hydrologist) developed the hydrology, water balance and design flows for the pond and spillway. SRK then prepared construction drawings for the spillway and forwarded them to the site. Eric Denholm of (DTI) was responsible for on-site supervision and construction was completed by DTI personnel. The project was financed partly by DIAND and partly by DTI. Authorisation to proceed with the work was received on September 10, 1998. Work started on September 14, 1998 and was completed on October 15, 1998.

This report provides a summary of the hydrology and water balance analyse, design details of the spillway and outlet facility, construction drawings and a summary of the work completed.

2. Background

The Little Creek seepage collection pond was built in 1990 by Pelly Construction. The dam was designed for Curragh Resources Inc. by SRK (SRK, 1990). The dam is about 13.5 metres high and based on a recent survey, the low point of the crest is at El. 1113.8. The current maximum operating level of the pond is El. 1112.6, which would provide an operating freeboard of 1.2m. The crest of the dam was originally designed with a crest elevation of EL. 1114.5m and a maximum operating freeboard of 1.9. The original design also provided for storage of a 200 year, 24 hour runoff event based on a catchment of 0.26 km². Under these conditions, there would have been a 1m freeboard maintained below the dam crest and construction of an emergency spillway was deferred until more accurate actual seepage and runoff data was collected.

The pond was designed to collect seepage from the Vangorda Pit and waste dumps. As the seepage was expected to be acidic and high in metal content, a system was put in place to pump the collected water to a treatment plant before discharge into the adjacent Vangorda Creek. The pond contains an intake and wet well with a pumping system capable of up to 900 USgpm. An HDPE pipeline conveys the water to the treatment facility. Current practice at the mine during the shutdown period, is to pump water collected in the pond to the Vangorda pit.

The design objectives for the spillway that were agreed to at the August 1998 meeting included the following:

- pass the peak flow during a 200 year runoff event while maintaining a reasonable freeboard;
- convey the flow to Vangorda Creek without impacting the toe of the dam and without significant erosion to the hillside;
- develop operating rules for the pond that would contain the runoff event within the pond and minimise the likelihood of discharge through the spillway;
- consider in the design, mitigating factors such as the ability to maximise the pump rate to the treatment plant and temporally interrupting drainage inflow from the Vangorda Pit.

3. Flood Hydrology

The key design objective for the emergency spillway in the Little Creek Dam is to allow safe passage of the 200-year flood event. In assessing how the spillway would perform during this event, it was necessary to develop an understanding of the volume characteristics of the flood. Determination of the instantaneous peak flow was of less importance because the Little Creek Pond possesses a large storage capacity that would significantly attenuate this peak. This section of the report describes the steps taken to estimate the water balance associated with the pond during a 200-year flood event. As it was unknown over what time frame the flood inflows could exceed the pumping capacity to the water treatment plant and result in a continuous rise of the reservoir level, the 200-year flood event was characterised for a range of durations from one day to one year.

The flood event was estimated using a technique known as Regional Analysis. This technique involves transposing the flood data from regional streamflow gauging stations to the dam site. Application of the technique entailed six broad steps.

Firstly, the networks of streamflow gauging stations in the central Yukon and the interior of Alaska were searched to find data representative of the dam site. In conducting the search, emphasis was placed on finding stations that gauge small catchments and that also have long periods of record. Table 1 provides details of the 14 stations that were identified in the search. These stations command catchments ranging from 13.7 to 7,250 km² and have records that span from 7 to 48 years. The flood data were obtained from the gauging networks of three government agencies, namely the Water Survey of Canada (WSC), Indian and Northern Affairs (IANA) and the U.S. Geological Survey (USGS). Perhaps the most important data were obtained from the streamflow gauging station located on Vangorda Creek. The Little Creek Pond is wholly contained within the catchment of this stream.

The second step in the analysis involved patching the daily streamflow records by making estimates for missing data. The records for twelve of the stations were complete and required no patching. The records for Vangorda Creek and Wheaton River required some infilling of missing data. Details of the patching exercise are presented in the footnotes to Table 1.

The third step involved extracting a total of ten annual series of flood values from each daily streamflow record. All of the annual series had one characteristic in common – they contained a list showing the highest discharge in each water year (The water year was defined as the period October 1 to September 30). The differences in the ten annual series related to the period over which the highest discharge was defined. The defined periods were 1, 2, 3, 7, 10, 30, 60, 90, 183 and 365 consecutive days.

The fourth step entailed fitting a theoretical frequency distribution (Log-Pearson Type III) to each annual series assembled in Step 3. This meant a total of 140 fittings were undertaken (i.e., 14 stations x 10 annual series per station). The fitted frequency distributions were then used to predict the magnitude of the 200-year flood discharges at each station for durations ranging from 1 day to 365 days. Steps 3 and 4 were performed using a suite of computer programs developed by the USGS for processing hydrological data (viz., IOWDM2.4, SWSTAT3.2 and ANNIE2.5). Table 1 summarises the results obtained from performing Step 4. To facilitate comparison of the floods generated on the differently sized catchments, the flood values in Table 1 have been expressed as unit discharges in units of $L/s/km^2$ (i.e., the absolute flood discharge has been divided by the contributing catchment area).

The fifth step involved transposing the 200-year flood values from the gauged sites to the Little Creek Pond catchment. Originally, it was thought that the unit flood discharges would exhibit an inverse trend with catchment area, particularly for the shorter durations of 1 to 7 days (i.e., it was assumed that the unit flood discharges would increase with decreasing catchment area). Plots of unit flood discharge versus catchment area revealed this was not the case. For the range of catchment sizes used in this analysis, the unit flood discharges were found to be independent of catchment area and, therefore, no adjustment was necessary to make them representative of the flood hydrology of the Little Creek Pond catchment. Based on the unit flood discharges in Table 1, two estimates of the inflow hydrograph to the Little Creek Pond were prepared, one being designated the “best estimate” and the other the “conservative estimate”. The former estimate was determined by taking the average of the unit flood discharges of all 14 stations. An examination of Table 1 shows that the “best estimate” values are all greater than the predicted 200-year flood values for Vangorda Creek, which is the gauging station believed to be the most representative of the Little Creek Pond flood conditions. The “conservative estimate”, on the other hand, was derived using an envelope approach. For durations from 1 to 7 days, the “conservative estimate” was set equal to the maximum of the flood values predicted

for the 14 streamflow gauging stations. For durations greater than 7 days, the "conservative estimate" was set equal to a value between the highest and the second highest flood values. This latter procedure was adopted because the highest flood values in this table, for durations of 10 to 365 days, were judged unrepresentative of the conditions at the Little Creek Pond. The highest flood values are associated with a catchment that has a mean annual runoff (MAR) of 624 mm, which is over three times greater than the estimated MAR of the Little Creek Pond catchment.

The sixth and final step in the analysis entailed constructing the 200-year flood hydrograph for the Little Creek Pond catchment. Two estimates of this hydrograph were created, one based on the "best estimate" values of unit discharge and the other on the "conservative estimate" values. Figure 4 graphically portrays these two hydrographs and the following points should be noted:

- The hydrographs possess a daily time step and cover the period from January 1 to December 31;
- The peak daily discharge occurs on May 31 (based on the approximate average date on which the peak is observed to occur at streamflow stations in the region);
- The hydrographs represent the runoff from the total area that drains by gravity to Little Creek Pond, including the area controlled by the Vangorda Waste Dump collection ditch (a total of 0.72 km²); and,
- The hydrographs were given a "symmetrical" shape.

To create the "symmetrical" shape, the flow rate was made to progressively increase towards the peak and then progressively decrease away from it. This was accomplished by placing the daily flows, from largest to smallest, in an alternating pattern about the peak. Accordingly, the largest daily flow was assigned to May 31, the second largest flow to May 30, the third largest flow to June 1, the fourth largest flow to May 29 etc. Beyond the tenth largest flow, this placement pattern was modified to create a skewed appearance to the hydrograph to approximate the shape of natural hydrographs in the region.

The 200 year "best estimate" hydrograph has a daily average peak of 148 L/s, which corresponds to a total volume of 12,800 m³ during that day. The similar numbers for

the 200 year "conservative estimate" hydrograph are 284 L/s and 24,600 m³. The 200 year "best estimate" and "conservative estimate" hydrographs have annual average flows of 10.8 L/s and 14.4 L/s, respectively. As a comparison, the long-term average yield from the Little Creek Pond catchment is estimated to be about 4.4 L/s.

4. Water Balance Analysis

The seepage collection system for the Vangorda Mine comprises the following elements:

- A storage reservoir (Little Creek Pond) with an estimated capacity of 122,000 m³ below the spillway invert elevation of 1112.8 m;
- A channel for collecting seepage from the southern portion of the Vangorda Waste Dump (known as the Vangorda Waste Dump Collector Ditch);
- The Vangorda Pit with a total capacity of about 4,600,000 m³;
- A water treatment plant with a flow capacity of 2000 USgpm (10,900 m³/d);
- A pumping system for delivering water from the Vangorda Pit to the Little Creek Pond; and,
- A pumping system for delivering water from the Little Creek Dam to the water treatment plant with a maximum capacity of 900 USgpm.

Ideally, these elements should act together to prevent the release of contaminated drainage to the receiving environment from Little Creek Pond. To demonstrate the pond's current handling capacity SRK has modelled the impact of the 200 year flood event.

The model is basically a spreadsheet set up to simulate the performance of the Pond during the occurrence of the 200-year wet year. The model was operated on a daily time step for the period January 1 to December 31. Inflows to the Pond were characterised using the estimates of flood hydrology made in Section 3, both for the "best estimate" and "conservative estimate" hydrographs. The model was run under the following conditions:

- No significant reclamation measures were assumed to be implemented at the Vangorda Waste Dump. These measures will result in an estimated 20% reduction of the catchment area draining to the pond by gravity. For the purpose of this study, the catchment area was assumed to remain unchanged from what it is today (i.e., 0.72 km²).
- Water was assumed to be pumped from the pond to the water treatment plant at a rate of 600 USgpm. This is 67% of the installed pump capacity of 900 USgpm and 30% of the design capacity of the water treatment plant (2000 USgpm).
- The reservoir was assumed to be drawn down to a minimum operating level of 1109.0 m, which is 2 m higher than the value recommended in the pond's current operating manual.
- Water could be pumped from the Vangorda Pit to Little Creek Pond at a maximum rate of 900USgpm.

Further details on the model setup, particularly as they relate to the adopted operating rule for the reservoir, are presented in Table 2.

The spreadsheet model was run twice, once with the "best estimate" hydrograph and once with the "conservative estimate" hydrograph. Figures 4 and 5 present the results for the respective model runs. Each figure comprises five graphs, one for each of the five main components of the pond's water balance. The top two graphs represent the main inputs to the pond, namely:

- runoff from the total catchment that drains by gravity to the pond;
- and, dewatering flows pumped from the Vangorda Pit to the pond. The next two graphs represent the simulated outflows from the pond and comprise:
- abstraction of water from the pond to the water treatment plant; and,
- spillage through the pond's emergency spillway. The bottom graph depicts how the water level in the reservoir varied during the simulation. This last graph represents the storage component of the pond's water balance.

Figure 5 indicates how the pond would behave during the passage of the best estimate for the 200-year wet year. As indicated by the two bottom graphs, no spillage would occur during this event. It should be noted, however, that during the peak inflow

months, there would be no dewatering of Vangorda Pit. The excess water in the pit would be stored in the Vangorda Pit for treatment in the following year.

The spreadsheet model was also run using the "conservative estimate" hydrograph. Figure 6 shows the simulated behaviour of the pond using the more extreme estimate of the 200-year wet year. As shown the lower two graphs, the water level in the reservoir would rise to the spillway invert elevation (1112.8 m), allowing a small amount of spillage to occur.

A third simulation was undertaken to ascertain whether or not this spillage could be prevented if a more stringent set of operating rules was adopted. Specifically, the pumping rate from the pond to the water treatment plant was increased from 600 to 900 USgpm and the minimum operating level was lowered from 1109.0 m to 1107.0 m. These revisions resulted in no spillage.

5. Spillway Design

5.1 Culvert Sizing and Design Discharge

The analysis undertaken in Section 4 indicates that the seepage collection system has a reasonable likelihood of preventing spillage of water during the 200-year wet event. However, this potential is predicated on two important conditions:

- Neither the pumping system nor the water treatment plant would experience a mechanical failure during periods of high inflow to the reservoir; and,
- Site personnel would monitor the conditions at the pond on a frequent basis, especially during periods of high potential for high inflows.

Because neither of these conditions can be guaranteed absolutely, there was a need to provide the pond with an emergency spillway. This section describes the analysis undertaken to estimate the design discharge for this structure.

The pond has a large storage capacity relative to the size of its catchment. Accordingly, the storage capacity can be used to reduce the instantaneous peak of the inflow hydrograph, resulting in a smaller outflow peak through the spillway. The amount of reduction that can be achieved is a function of the following factors:

- shape and volume of the inflow hydrograph;
- The storage characteristics of the reservoir; and,
- The hydraulic characteristics of the spillway's control section.

The first two items were quantified, however, the last item was determined by trial and error using different pipe diameters and discharges.

The following data and assumptions were used in performing the trial and error process:

- The spillway would have an invert level of 1112.8 m;
- The peak daily volume of the inflow hydrograph would be 24,600 m³ based on the "conservative estimate" presented in Section 3;
- The water level in the reservoir would be just lapping at the spillway crest when the peak daily flood occurred; and,
- The storage characteristics of the reservoir are as indicated by the height-capacity curve presented in the design report for the Little Creek Dam (see Figure 4.3 of SRK Report 60627).

Using the above information, it was determined that a culvert with diameter of 900 mm would be adequate to pass the 200-year flood. With this size of culvert and the assumptions outlined above, the design discharge for the spillway was estimated to be 0.8 m³/s. To pass this discharge, the reservoir level would have to rise to an elevation of about 1113.6 m, or 0.8 m above the spillway invert level. Considering that the low point on the dam's crest is at elevation 1113.8 m, the flood would be accommodated with a freeboard of about 0.2 m.

5.2 Plunge Pool

In order to dissipate the energy in the water discharging from the culvert and to minimise scouring of the outlet channel, a plunge pool was included in the spillway design. The plunge pool design was based on a method derived by Blaisdell and Anderson (1991). The original design was based on the following design parameters:

- Design Flow = $0.8 \text{ m}^3/\text{s}$
- Vertical distance between culvert invert and pond surface = 1.7m
- Riprap $d_{50} = 0.25\text{m}$
- Culvert exit velocity = 2.2 m/s
- Velocity of jet as it plunges into pool = 6.7 m/s
- Slope of culvert = 1 percent

The plunge pool was to have a base of 1m square with the deepest point of the pool located 2.4m downstream of the culvert outlet. The design also required the deepest point to be 4.4 metres vertically below the culvert invert and 2.7 m vertically below the pond surface. The pond surface was to be 9.1 m long by 8.5 m wide. Design drawings are included in Appendix A.

During construction of the culvert, pool and the exit ditch, unexpected soil conditions required the following modifications to the design:

- Vertical distance between culvert invert and pond surface = 2.3m
- Riprap $d_{50} = 0.3$ to 0.5m
- Culvert exit velocity = 3.1 m/s
- Velocity of jet as it plunges into pool = 7m/s
- Slope of culvert = 3 percent
- Dist. of deepest point in pool below culvert invert = 3.7m
- Dist. of deepest point in pool below water level during the 200 year event = 1.4m
- Hor. Dist from the culvert invert to deepest point in the pool = 6.5m

The key change to the design was the relocation of the pool several metres away from the culvert invert. This would cause the cascading discharge to impact the riprapped sideslope rather than the pool itself. As a consequence additional scouring of the sideslope could result. DTI have placed oversized riprap ($D_{50} = 0.75\text{m}$) on the slope

as additional protection to prevent this scouring. However, as a contingency measure DTI is currently considering installing a half-round culvert chute from the culvert outlet to the pool tailwater level as a means of improving energy dissipation. Details of this flume would be finalised during the next inspection to the site by SRK.

As-constructed details of the plunge pool are shown on Figures 7 and 8.

5.3 Exit Chute

An outlet channel was also designed to take flow from the plunge pool away from the toe of the dam and direct the flow into an area that would minimise erosion without the need for a costly flume or riprapped channel down to Vangorda Creek. The as-built channel has an invert at the plunge pool outlet of El. 1109.32m. The ditch runs initially for a distance of about 26m at a grade of 5 percent. The ditch then steepens to a grade of 18 percent. The entire ditch has a base width of about 1 metre and is protected with riprap. Details of the ditch are shown in Figure 8.

6. Construction

6.1 General

Work on the Little Creek Dam emergency spillway commenced on September 14, 1998 and was completed on October 15, 1998.

The spillway facility comprises a 24.4 metre long x 900mm diameter corrugated metal pipe (CMP) with an inlet invert of El. 1112.8m located at west abutment of the Little Creek Dam as shown on Figure 2. A riprap lined plunge pool was constructed below the culvert to dissipate energy from the flow. An outlet ditch directs flow from the pool away from the toe of the dam and into an area of thick natural vegetative cover, where the risk of significant soil erosion is low.

Construction supervision was performed by Eric Denholm of DTI and the installation was performed by DTI personnel. An as-built survey was performed on October 28, 1998 by Yukon Engineering Services (YES).

The work was inspected on October 7, 1998 by Mr. B. McAlpine of DIAND, Water Resources, Whitehorse.

An inspection of the emergency overflow system by Peter Healey of SRK is tentatively scheduled for the summer of 1999 as part of the annual geotechnical inspection of the Vangorda Plateau minesite.

6.2 Work Activities

6.2.1 Source of Riprap Protection

The source of the riprap erosion protection, used to line the pond and the outflow ditch, was obtained from a quarry located at the west extent of the Grum rock dump. The quarry was previously established while the mine was operating. The rock in the riprap quarry is hard and angular and does not contain any visible sulphide mineralisation.

The quarry was inspected on August 25, 1998 by Messrs. Denholm (DTI), Healey (SRK) and McAlpine (DIAND). It was concluded, at that time, that sufficient blasted inventory was present to meet the needs of the project although the blasted inventory would need to be cleaned of fines prior to use as riprap.

In the absence of a conveniently located and sized screening facility, the blasted inventory was sorted or "cleaned" using a CAT 235 backhoe. Loose material was cascaded over a hard edge or a loose pile of between 2 to 4m in height to segregate the fine material from the coarse. The coarser material was then loaded from the toe of the slopes and hauled to Little Creek dam.

An estimated 125 m³ of riprap was hauled to Little Creek dam with an average particle size diameter of 250 to 300 mm.

6.2.2 Culvert Excavation

The excavation for the CMP was performed with the CAT 235 backhoe with field control performed by Eric Denholm.

Excavation started at the upstream side of the dam to full depth and proceeded towards the downstream side of the dam. The maximum depth of excavation was about 2m.

The bottom width of the excavation varied from 2.7 metres to 3.1 metres (three times the pipe diameter). The sideslopes of the excavation were sub-vertical and flattened sufficiently to provide a safe work environment in the excavation.

The material excavated was a highly compacted clay till with a minor quantity of stones.

The initial excavation resulted in a grade of about 5 percent over a length of approximately 5 m. This section of the excavation was backfilled with compacted clay till in order to achieve design grade.

Following excavation with the backhoe and prior to assembly of the CMP, small depressions and irregularities in the bottom of the excavation were filled in by hand using clay till. The fill was then compacted to form a relatively smooth and even surface along the bottom of the excavation.

The overall completed grade of the excavation was surveyed at about 3 percent.

6.2.3 CMP Installation

The spillway culvert consists of a 900mm diameter CMP, with a wall thickness of 2mm. The culvert consists of four pipe sections each about 6m in length with three annular couplers. The in-place total assembled length was 24.4m.

The overhang of the culvert at the upstream end is about 0.3m (measured along the base). The resulting overhang at the downstream end is 3.5 metres (bottom of pipe).

6.2.4 Pipe Backfill

Following assembly of the CMP, clay till was placed under the haunches of the pipe and compacted by hand tampers.

Clay till, excavated from the dam was used as backfill around the pipe. Rocks greater than about 50 to 75mm in size were hand-picked from the till prior to compaction using a 56cm vibratory plate compactor in 150mm to 250mm lifts.

Compaction was achieved with 5 passes with the compactor.

6.2.5 Excavation of Plunge Pool

The initial grubbing of the area of the plunge pool resulted in a greater than anticipated depth of organic material. This meant that the actual ground elevation following grubbing was lower than expected, which required changes to the design.

These changes including moving the plunge pool further away from the culvert pipe and lowering the invert of the ditch outlet from 1110.63m to 1109.32 m. The revised outlet elevation allowed for the design 200 year flow event to pass within the natural ground rather than a constructed dyke. In the revised design, the constructed dyke around the east edge of the plunge pool and ditch provides 0.5 metres freeboard above the 200 year flow event.

The as-constructed configuration of the plunge pool and ditch is shown on Figures 7 and 8

6.2.6 Excavation of Exit Ditch

One small area of frozen ground was uncovered during the grubbing. The frozen ground covered an area of approximately 1.5m x 2.0m and was located above the west side of the outlet ditch approximately 20 metres from the ditch inlet. The area of frozen ground was located on the sideslope in natural ground approximately 1.0m above the top of the required ditch freeboard.

Survey results indicated that the grade of the ditch over the initial 26m was 5 percent. The bottom width of the ditch varied from 1.5m to 1.8m. The sideslope on the west side was in natural ground at a slope flatter than 2:1 (H to V). The original ground was grubbed clear of organic material to a height higher than the freeboard required in the design. The sideslope on the east side was established at 2:1 (H to V) in natural ground, which had already been cleared and grubbed.

An extension of the lower end of the ditch provides control over a steeper section of ground across an "old" skid trail. The purpose of the extension is to prevent significant soil erosion by allowing flow to discharge into an area of thick vegetation below the skid trail. The extension was estimated to be at a grade of approximately 18 percent.

6.2.7 Dyke Construction

A containment dyke was required along the lower (east) edge of the plunge pool and outlet ditch to provide the design freeboard (min. 0.5m) above the 1:200 year design event.

The dyke was constructed using clay till, which was excavated during construction of the plunge pool or otherwise locally borrowed. The clay till was fine grained, generally free of stones and similar in appearance to the material excavated from the dam.

The dyke around the plunge pool was constructed with a width at the base of between 2.5 and 3.0m and with sideslopes at 2:1. The dyke along the outlet ditch was constructed with a base width of between 1.5 to 2.0m and with sideslopes of 2:1. The construction method used for the dyke around the plunge pool and along the original design ditch (0 to 30m) involved spreading clay till with the backhoe, smoothing the till by hand, picking out stones greater than about 75mm in size, compacting with 3 to 5 passes of the 56cm vibratory plate compactor in lifts varying from 200 to 250mm in thickness.

The dyke was constructed to elevations estimated to provide the required freeboard as determined using field methods.

6.2.8 Placement of Riprap

Riprap, which had been previously hauled from the quarry, was placed at the inlet and outlet of the CMP. Sufficient riprap was placed to create an apron around the pipe and protect the surrounding soil from erosion.

Riprap was also placed as a lining for the plunge pool and outlet ditch. The rock was placed approximately 500 to 800 mm thick in the plunge pool and approximately 300mm thick in the ditch. All of the available riprap rock (est. 125m³) was utilised.

The fines content of the riprap rock was generally low, although a minor quantity was present due to the incomplete cleaning at the quarry and due to the rehandling with the backhoe at Little Creek Dam.

A "pocket" of large boulders was constructed below the outlet of the CMP in order to provide additional erosion protection and energy dissipation. This pocket was in addition to the required 500mm thickness.

Additional riprap was placed under the downstream end of the CMP against the edge of the dam in order to provide extra physical support for the larger than designed CMP overhang. The effective overhang was reduced from 3.5 metres (from edge of dam) to 2.5 metres (from edge of rip rap).

Larger sized riprap was placed along the ditch extension for protection against the higher velocities that would be generated on this steeper section.

6.2.9 Final Dressing

The work areas around the plunge pool and outlet ditch were dressed at the completion of construction to remove unsightly and dangerous holes and piles. In particular, a large (2 metres high) windrow of organic debris which had been created as a result of clearing and grubbing, was removed.

6.2.10 Final As-Built Survey

An as-built survey of the work was complete by YES during a final survey relating to the work performed by the Ross River Development Corp. for DIAND.

The as-built survey was performed on October 28, 1998 following completion of construction.

7. Conclusions and Recommendations

As a result of the design changes to the plunge pool, any flow through the culvert would impact the riprapped sideslopes of the plunge pool before contacting the ponded water. This could cause erosion of the riprap and possible erosion of the toe of the dam. Although, DTI placed additional oversized riprap in this area, DTI should also consider installation of a half-round flume, which would be attached to the outlet culvert to convey flow directly into the plunge pool (see Figure 7). Modifications to the culvert may be required prior to the flume installation. Details of this flume would be finalised during the next inspection by SRK in 1999.

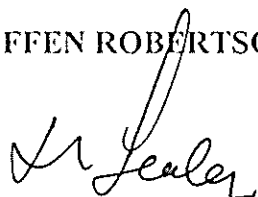
To lower the risk of spillage, the pumping system from the pond to the water treatment plant should maintain a pumping capacity of at least 900 USgpm. The mine should draw the water level in the LCD reservoir down to the 1109.0m level prior to the onset of winter. The current practice of pumping this water to the Vangorda Pit is acceptable during this period of suspended operations.

The mine should also fill in low points along dam crest, so that minimum elevation along crest is not less than 1114.0 m. This will provide a freeboard of 0.4 m during passage of the design flood (conservative estimate).

When funds become available, the mine should provide erosion protection for the lower steeper portion of outlet ditch that would convey the spillway releases from the plunge pool to Vangorda Creek.

This Report, ICD003.01 - Little Creek Pond Emergency Spillway Vangorda Mine, Yukon Territories has been prepared by:

STEFFEN ROBERTSON AND KIRSTEN (CANADA) INC.



Peter Healey, P.Eng.
Senior Project Engineer, GeoEnvironmental

8. References

SRK Report 160636 (1990) Vangorda Plateau Development, As-built Construction Report for Little Creek Dam.

Blaisdell, F. W., and Anderson, C. L. (1991). "Pipe Plunge Pool Energy Dissipator." Journal of Hydraulic Engineering, ASCE, Vol. 117, No. 3, pp.303-323.

Tables

Table 1 Estimated 200-Year Floods at Regional Streamflow Gauging Stations

Streamflow Gauging Station		Length of Record (years)	Catchment Area (km ²)	Mean Annual Runoff (mm)	Authority ^c	Average discharge in L/s/km ² for the following number of consecutive days ^d :									
ID No.	Name					1	2	3	7	10	30	60	90	183	365
15439800	Boulder Creek near Central	18	81.0	131	USGS	265	243	216	164	139	65	47	33	16	8.2
15535000	Caribou Creek near Chatanika	15	23.8	200	USGS	183	149	120	73	71	63	47	38	24	15
10AB003	King Creek at km 20.9 Nahanni Range Road	12	13.7	290	WSC	159	134	116	97	89	77	69	57	34	17
15344000	King Creek near Dome Creek	7	15.2	100	USGS	132	125	123	105	83	44	21	13	8.7	4.8
15511000	Little Chena River near Fairbanks	30	963	199	USGS	395	373	342	214	162	69	43	35	24	13
09EA004	North Klondike River near the mouth	21	1100	379	WSC	188	168	151	113	101	81	65	52	32	18
09BA001	Ross River at Ross River	33	7250	293	WSC	122	121	119	105	94	77	53	40	23	13
15484000	Salcha River near Salchaket	48	5618	261	USGS	362	301	262	176	147	86	58	50	32	17
09AD002	Sidney Creek at km 46 South Canol Road	11	372	350	WSC	247	212	182	131	120	90	65	52	30	20
09AG003	South Big Salmon River below Livingstone Creek	13	515	246	WSC	225	196	177	122	108	79	57	46	26	17
09BB001	South MacMillan River at km 407 Canol Road	21	997	624	WSC	240	237	224	188	187	132	107	81	48	26
10AA002	Torn Creek at km 34.9 Robert Campbell Highway	18	435	218	WSC	112	109	109	105	97	85	63	58	32	18
29BC003	Vangorda Creek at Faro Townsite Road ^a	16	91.2	235	IANA	177	148	123	89	79	70	48	37	23	13
09AA012	Wheaton River near Carcross ^b	29	875	285	WSC	100	99	97	88	79	55	46	38	24	14
Little Creek Dam Inflow (Best Estimate) ^{e,1}		n/a	0.72	193	n/a	208	187	169	126	111	77	56	45	29	15
Little Creek Dam Inflow (Conservative Estimate) ^g		n/a	0.72	193	n/a	395	373	342	214	173	98	69	58	38	20

Notes:

a) The gauging station on Vangorda Creek is operated on a seasonal basis. Missing data within the daily record of this station were patched using a correlation with WSC Station 09BC001 (Pelly River at Pelly Crossing).

b) For Wheaton River, the largest flood of record occurred in June 1980. Because it was important to include this flood in the frequency analysis, missing data in the 1980 daily record were patched.

c) WSC = Water Survey of Canada; IANA = Indian and Northern Affairs; USGS = United States Geological Survey

d) For each station and each duration, the annual series of flood data were fitted to the Log-Pearson Type III distribution to estimate the magnitude of the 200-year flood discharge. A visual inspection revealed that the Log-Pearson Type III distribution provided a good fit to the data sets for all but a few of the stations. For the Salcha River and Little Chena River, the fit was only fair for durations from 1 to 30 days because of the existence of a high outlier.

To facilitate comparisons between the different catchment sizes, the flood values in this table have been expressed as unit discharges in units of L/s/km² (i.e., the absolute flood discharges have been divided by the contributing catchment areas).

e) The "best estimate" was derived by taking the average of the unit flood values of all 14 streamflow gauging stations.

f) The data assembled in this table indicate that unit flood discharges for durations of 1 day to 365 days are essentially independent of catchment area. Thus, the unit discharges for the larger catchments could be used, without adjustment, to represent the flood conditions on the small 0.72 km² catchment commanded by the Little Creek Dam. One would expect a dependency on catchment area if larger catchments were included in the analysis or if durations less than a day were examined. For example, unit peak instantaneous floods should exhibit an increasing trend as catchment area decreases.

g) For durations from 1 to 7 days, the "conservative estimate" was set equal to the maximum flood value predicted for the 14 streamflow gauging stations. For durations greater than 7 days, the "conservative estimate" was set equal to a value between the highest and second highest flood values. This latter procedure was adopted because the highest flood values in this table, for durations of 10 to 365 days, were judged unrepresentative of the conditions at the Little Creek Dam. The highest flood values are associated with a catchment with a mean annual runoff (MAR) of 624 mm, which is over three times greater than the estimated MAR of the Little Creek Dam catchment.

Table 2 Summary of Assumptions and Data Used in Water Balance Spreadsheet

Item ^a	Value	Comment
Catchment area commanded by LCD ^b	0.72 km ²	Total area draining to LCD by gravity, including area commanded by VWD collection ditch.
Pumping rate from LCD to WTP	600 USgpm	This value represents a less-than-ideal level of pump discharge. At the time of its construction, the LCD was equipped with a pumping system capable of conveying 900 USgpm to the WTP. The WTP, in turn, was designed to treat a flow of 2000 USgpm.
Period that WTP is available to receive flows from LCD	May 1 to Nov 15	This was the assumed "activated" period for the WTP. During the remainder of the year, the WTP would be mothballed. The WTP would not, necessarily, operate continuously throughout the activated period.
LCD minimum operating level	42,000 m ³ (1109.0 m)	The LCD reservoir was assumed to be drawn down to this level before the WTP was mothballed for the winter.
Threshold reservoir storage for starting WTP ^c	55,000 m ³ (1109.8 m)	The WTP operates best if it is supplied a reasonably constant influent stream over a long time period. This condition can easily be met during spring freshet when runoff into the LCD is high but may be difficult to achieve during periods of low inflow. In such periods, the WTP is shutdown and water is allowed to accumulate in the LCD to a level that is sufficient to sustain the WTP for several days. The WTP is then reactivated and the water level is drawn down to the minimum operating level. The threshold criterion was built into the spreadsheet to simulate this periodic operation of the WTP during periods of low inflow to the LCD.
LCD full supply capacity	122,000 m ³	This is the total volume of the reservoir below the spillway crest elevation of 1112.8 m. The height-capacity curve for the LCD was obtained from the design report for this facility (see Figure 4.3 of SRK Report 160627, dated September 1990).
Period that LCD is available to receive dewatering flows from Vangorda Pit	Jun 15 to Nov 12	When a high snowpack portends the occurrence of a high inflow rate to the LCD, dewatering of the Vangorda Pit should be delayed until mid-June. By then, a large proportion of the spring runoff volume generated by the LCD catchment would have been treated by the WTP. During average climatic conditions, pit dewatering may commence earlier than June 15.
Maximum allowable reservoir storage while Vangorda Pit is being dewatered ^d	49,000 m ³ (1109.5 m)	This criterion was programmed into the spreadsheet so as to better reflect the actual operating conditions of the LCD. In essence, this criterion disallows pit dewatering while the water level in the LCD is high.
Average annual inflow to the Vangorda Pit	350,000 m ³	Estimated from volume of water accumulated in Vangorda Pit during the 1993 to 1995 mine shutdown. This volume comprises three main components, namely: leakage from the diversion ditches; groundwater discharge; and, runoff from the incremental catchment of the pit below the diversion ditches (approx. 0.8 km ²). During each year, an attempt should be made to pump this volume of water from the Vangorda Pit to the LCD and, in turn, to the WTP. This attempt may not be entirely successful during an extreme wet year - a portion of the year's inflow may have to be stored in the Vangorda Pit for treatment in the following year.

Notes:

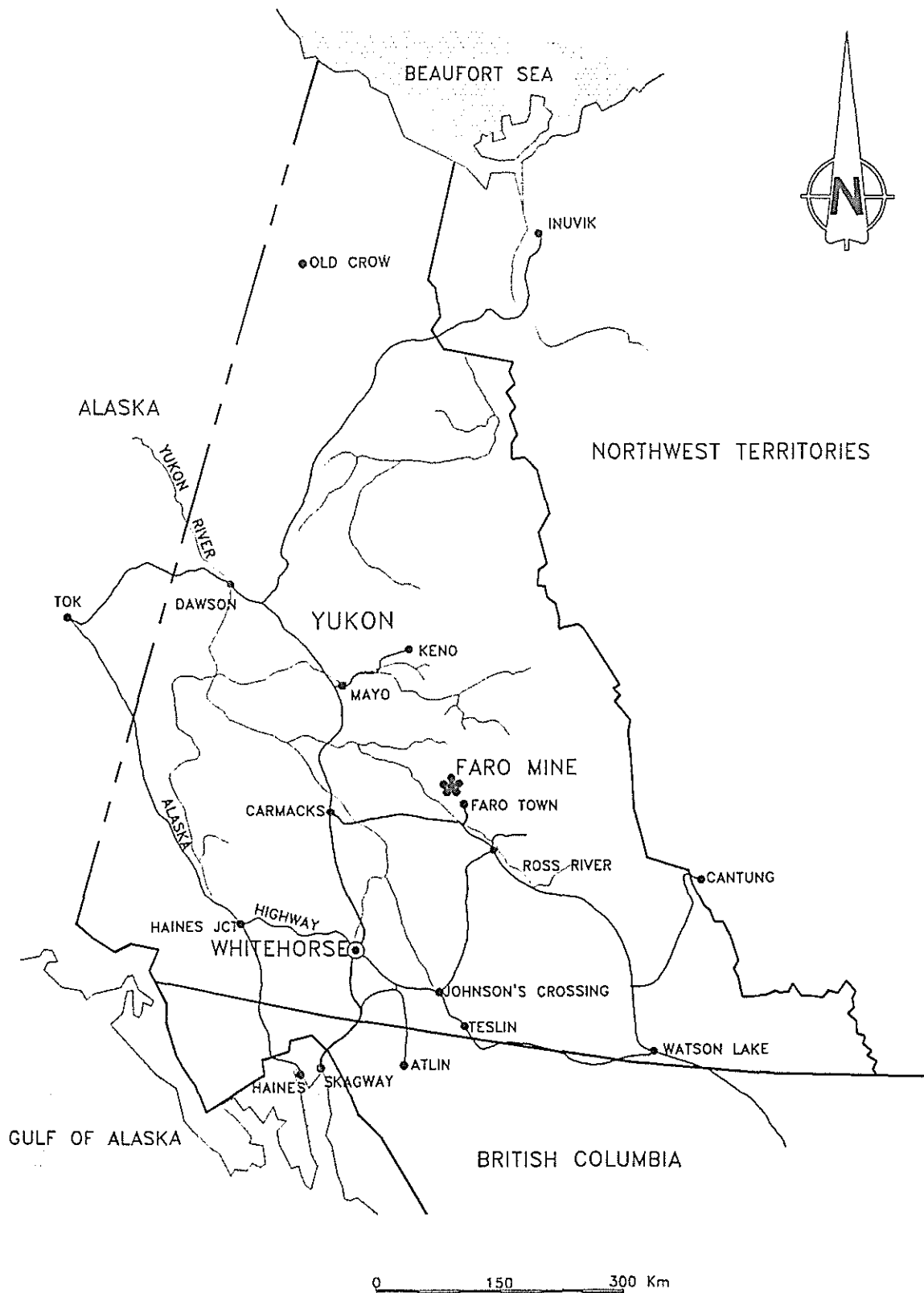
a) Abbreviations: LCD = Little Creek Dam; WTP = Water treatment plant; and, VWD = Vangorda waste dump.

b) The reclamation plan for the VWD calls for the construction of an impervious till cover over the entire waste dump. Drainage from the flatter portion of this cover will be clean and may be diverted away from the LCD. Such a diversion would reduce the LCD's catchment area to about 0.56 km². For the purpose of this study, the present-day catchment area of 0.72 km² was used in the water balance analysis.

c) The value adopted here for the threshold storage is somewhat arbitrary. In practice, the Receiver may use a different value to decide when to restart the WTP.

d) The selected value of 49,000 m³ is somewhat arbitrary. In practice, the Receiver may use a different value to decide when pumping from the Vangorda Pit to the LCD should proceed.

Figures



STEFFEN ROBERTSON AND KIRSTEN
Consulting Engineers

VANGORDA MINE

LOCATION MAP

DELOITTE & TOUCHE LTD.

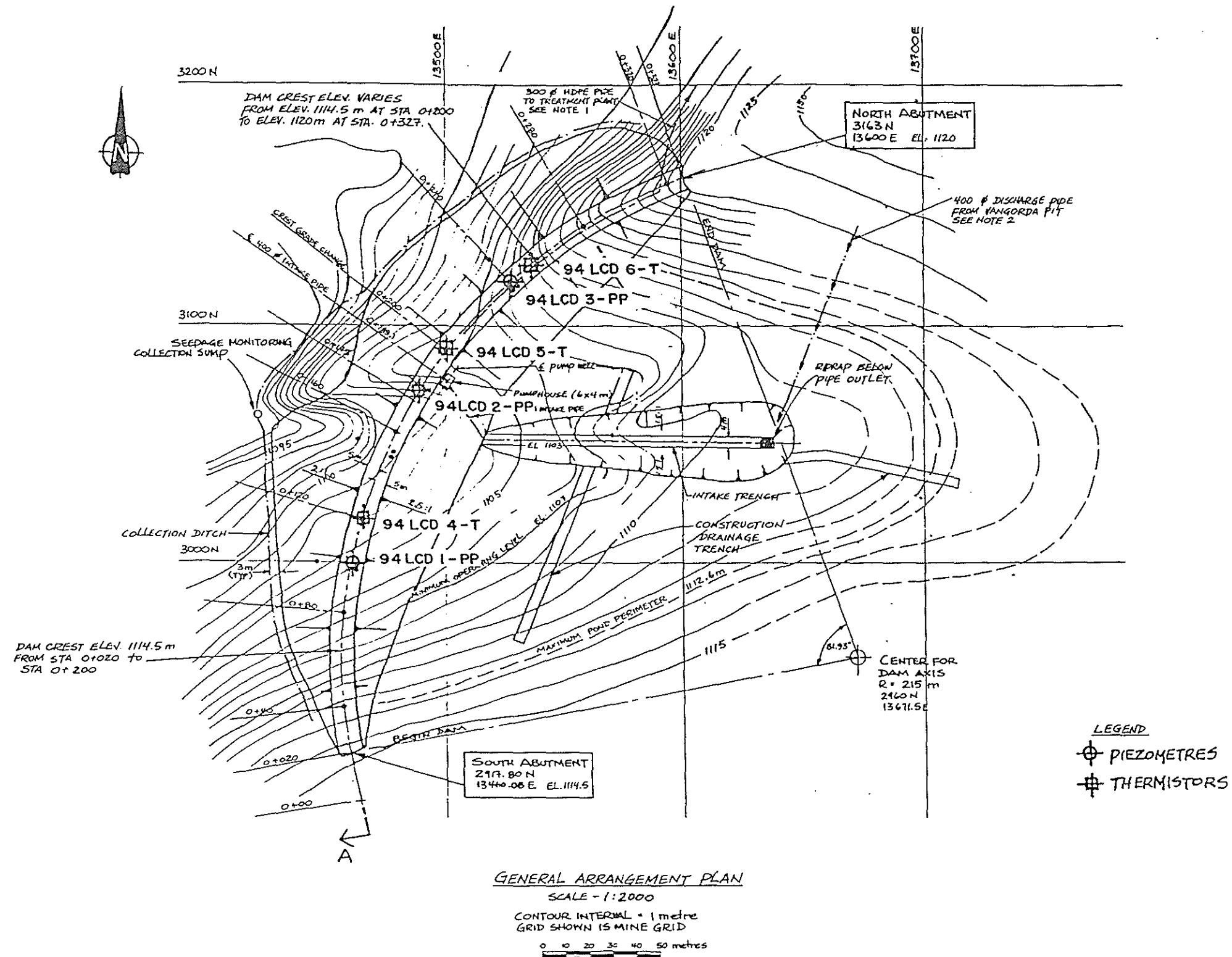
PROJECT NO.
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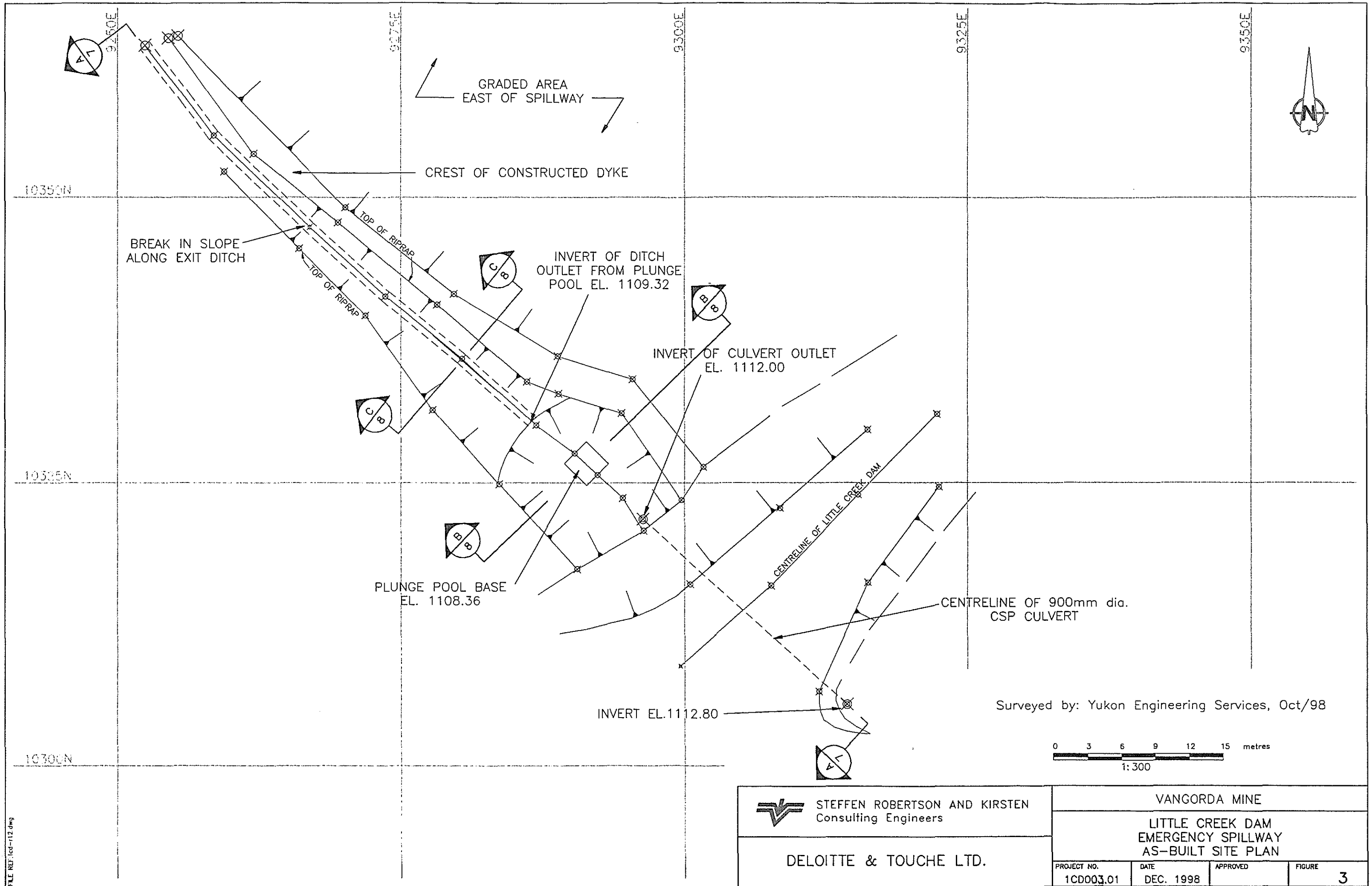
DATE
DEC. 1998

APPROVED

FIGURE

1





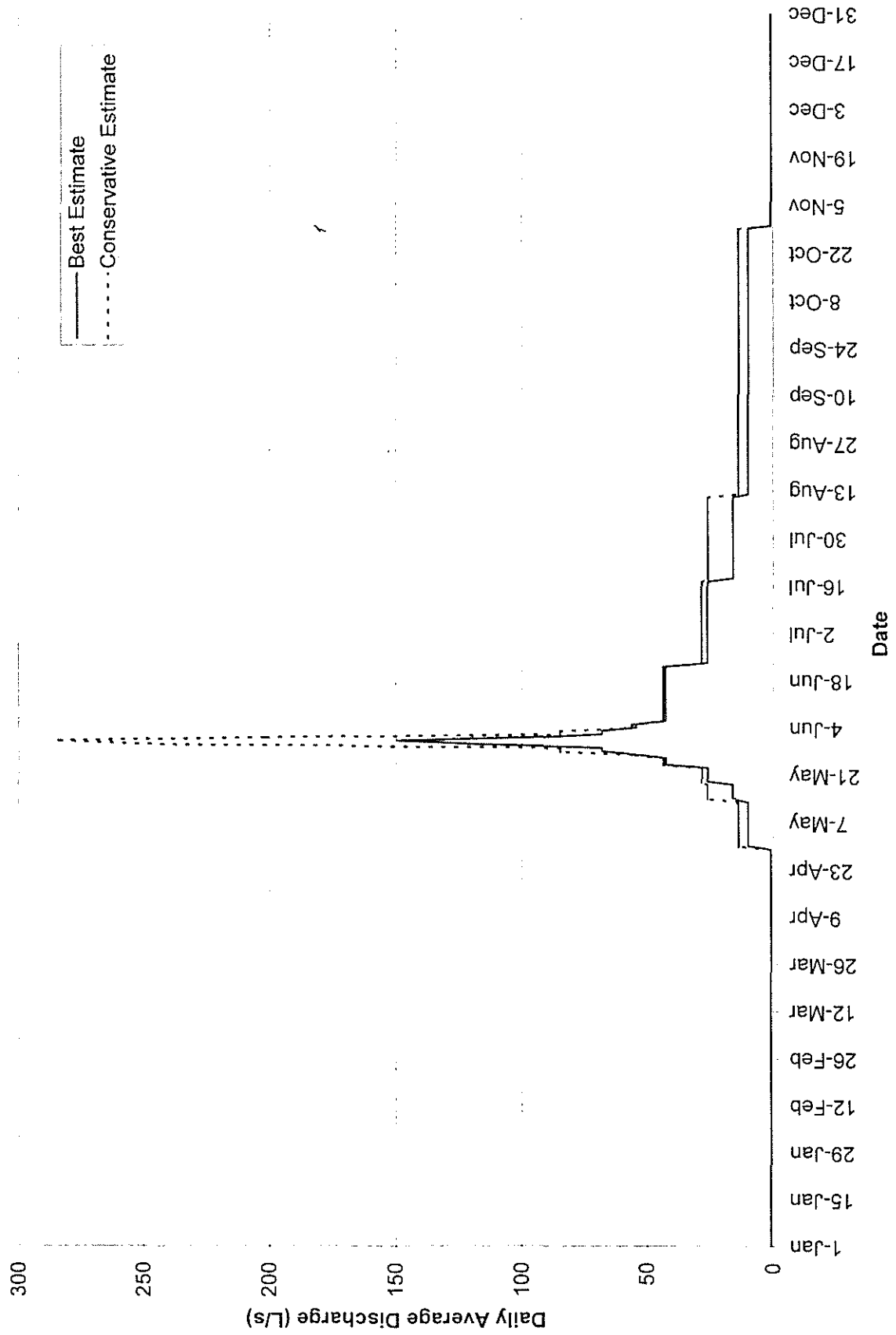


Figure 4 Synthesized 200-Year Inflow Hydrograph for Little Creek Pond

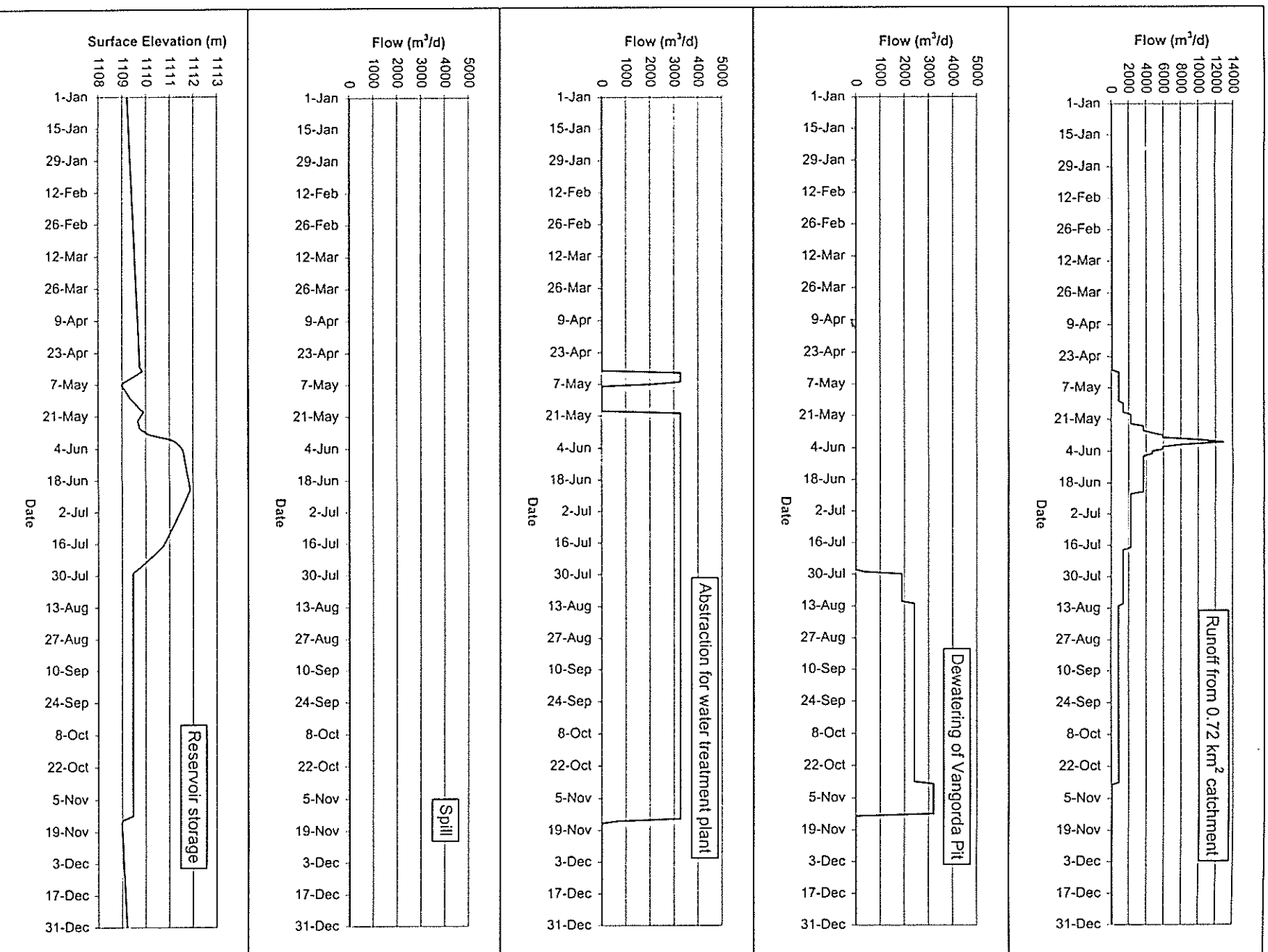


Figure 5 Simulated Behaviour of Little Creek Dam during an Extreme Wet Year
(Best Estimate of Wet Year with a Return Period of 200 Years)

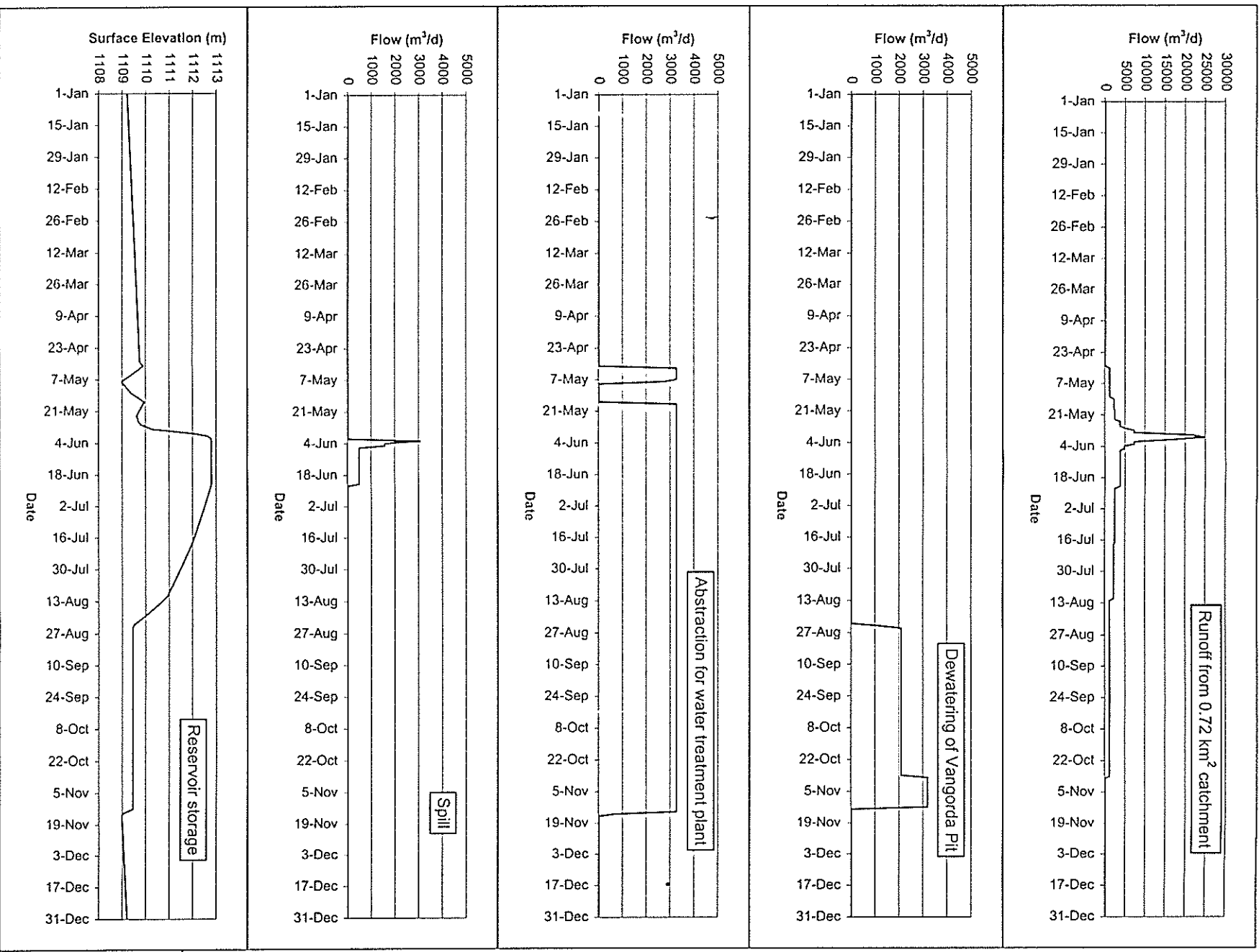
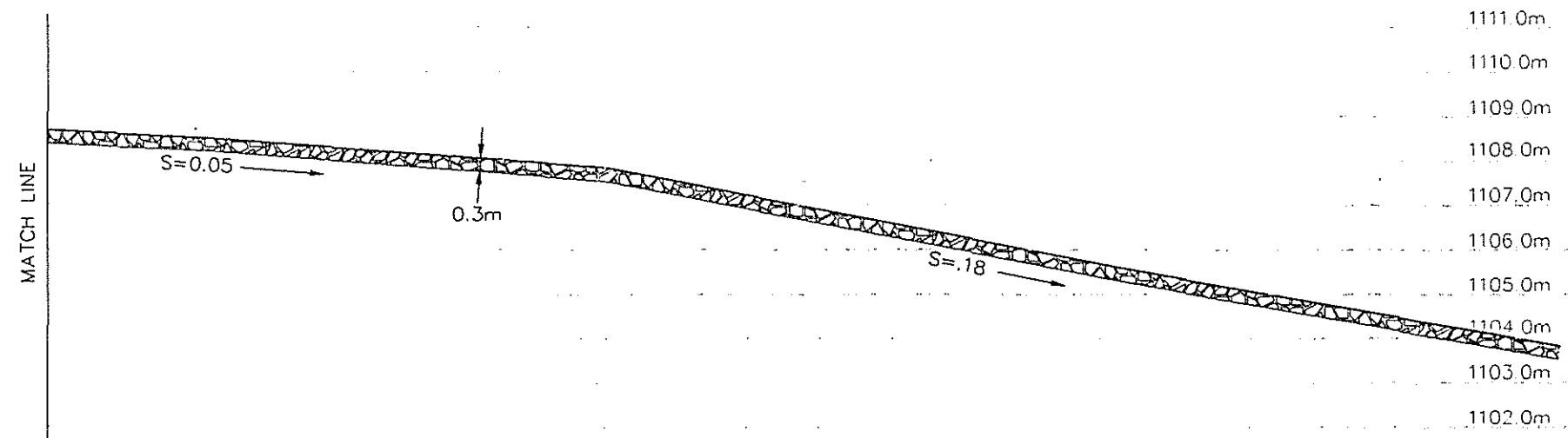
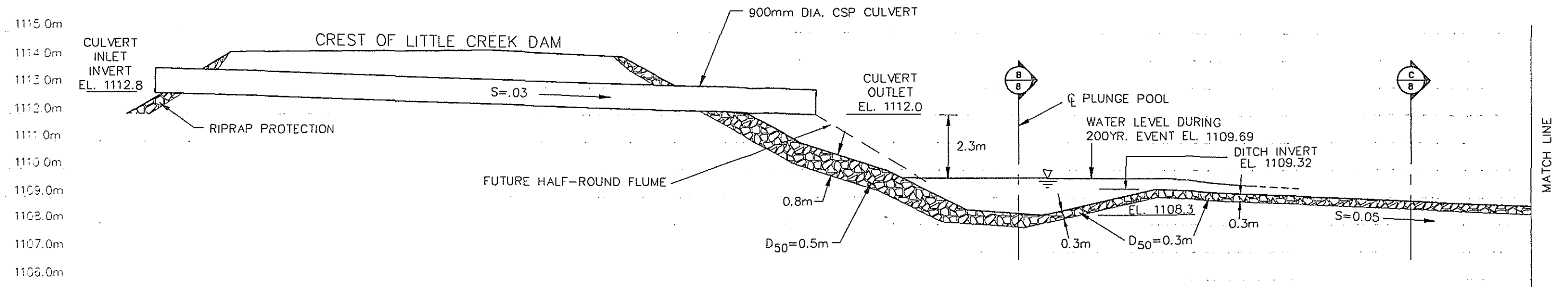
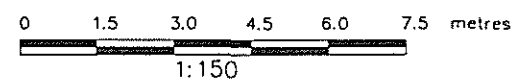


Figure 6 Simulated Behaviour of Little Creek Dam during an Extreme Wet Year
(Conservative Estimate of Wet Year with a Return Period of 200 Years)



LEGEND

———— As-Built Survey by Y.E.S. Oct 28/98
(top of rip rap)



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VANGORDA MINE

LITTLE CREEK DAM
SECTION A-A
SECTION ALONG SPILLWAY CENTRELINE

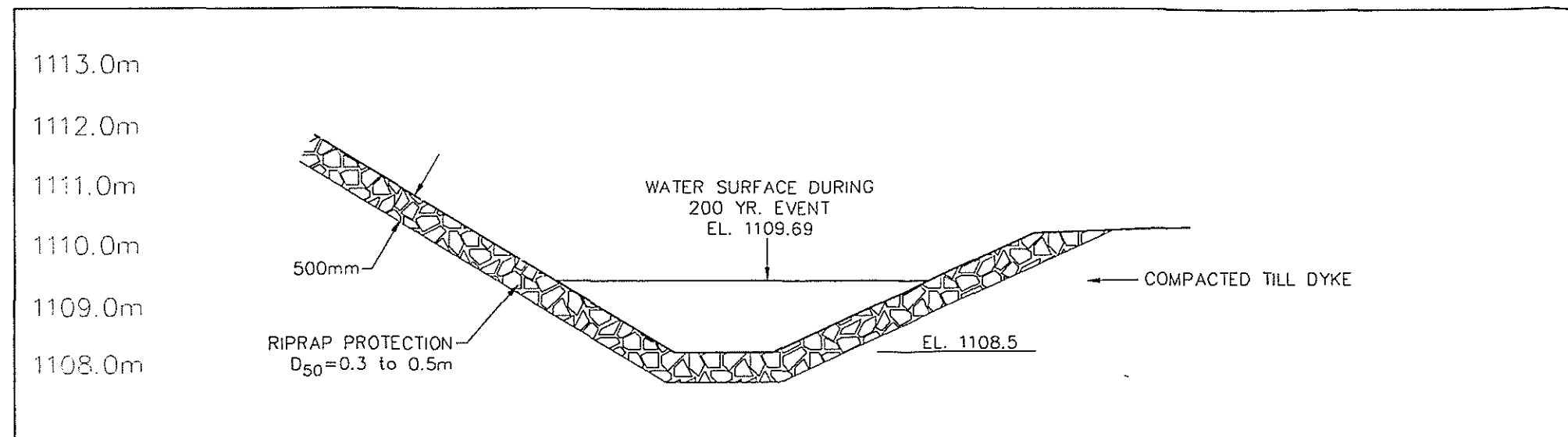
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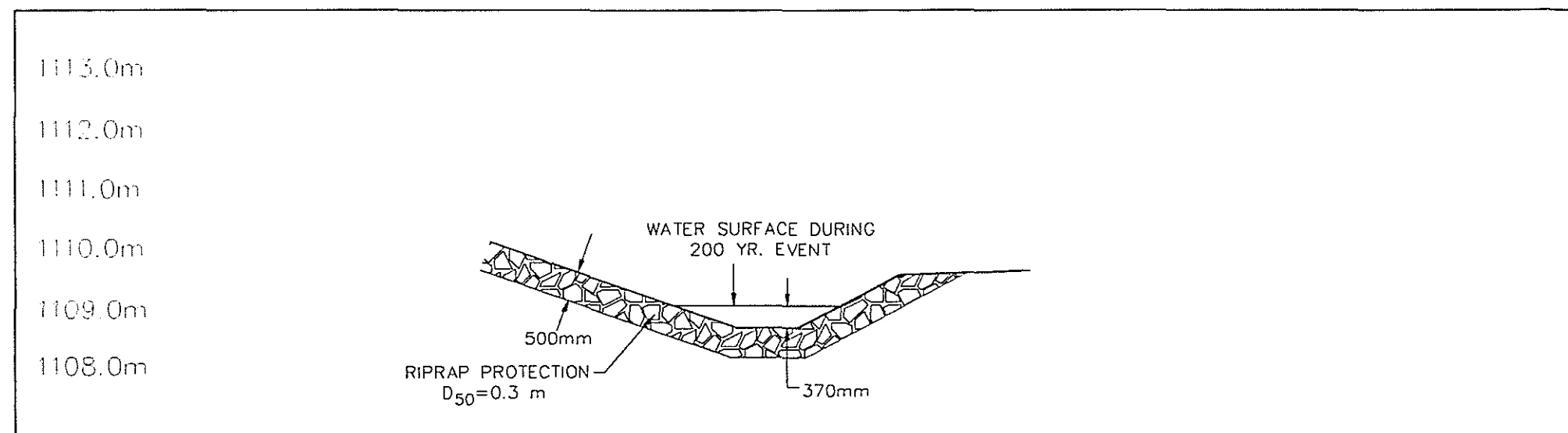
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FIGURE

7



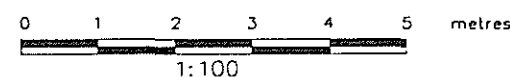
SECTION B-B – PLUNGE POOL



SECTION C-C – EXIT DITCH

LEGEND

————— As-Built Survey by Y.E.S. Oct 28/98
(top of rip rap)



STEFFEN ROBERTSON AND KIRSTEN
Consulting Engineers

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VANGORDA MINE

LITTLE CREEK DAM
EMERGENCY OVERFLOW SYSTEM
SECTIONS

PROJECT NO.	DATE	APPROVED	FIGURE
1CD003.01	DEC. 1998		8

Photos

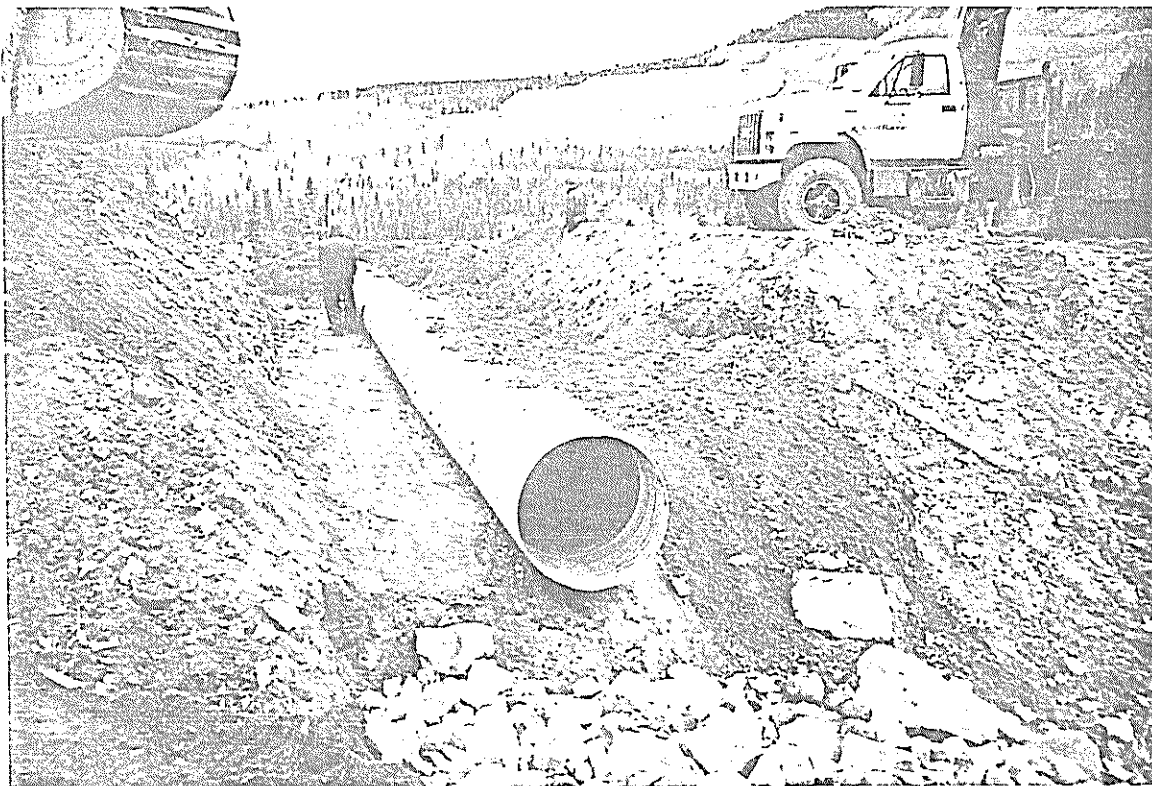


Photo 1 - Compaction of backfill around haunching of 900mm CNP culverts.



Photo 2 - Compaction of earth filled dyke.



Photo 3 - Placement of riprap in exit channel from plunge pool.



Photo 4 - Outlet of plunge pool.

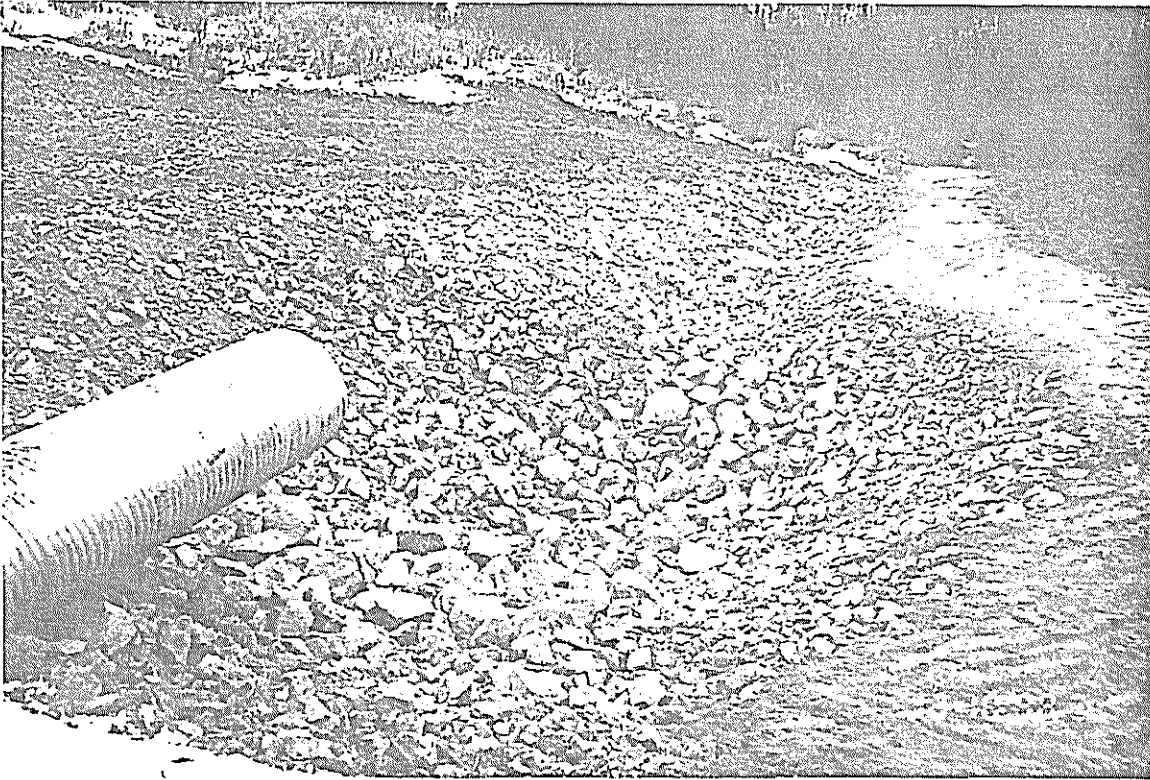


Photo 5 - View from Little Creek Dam looking out over culvert outlet and the plunge pool.

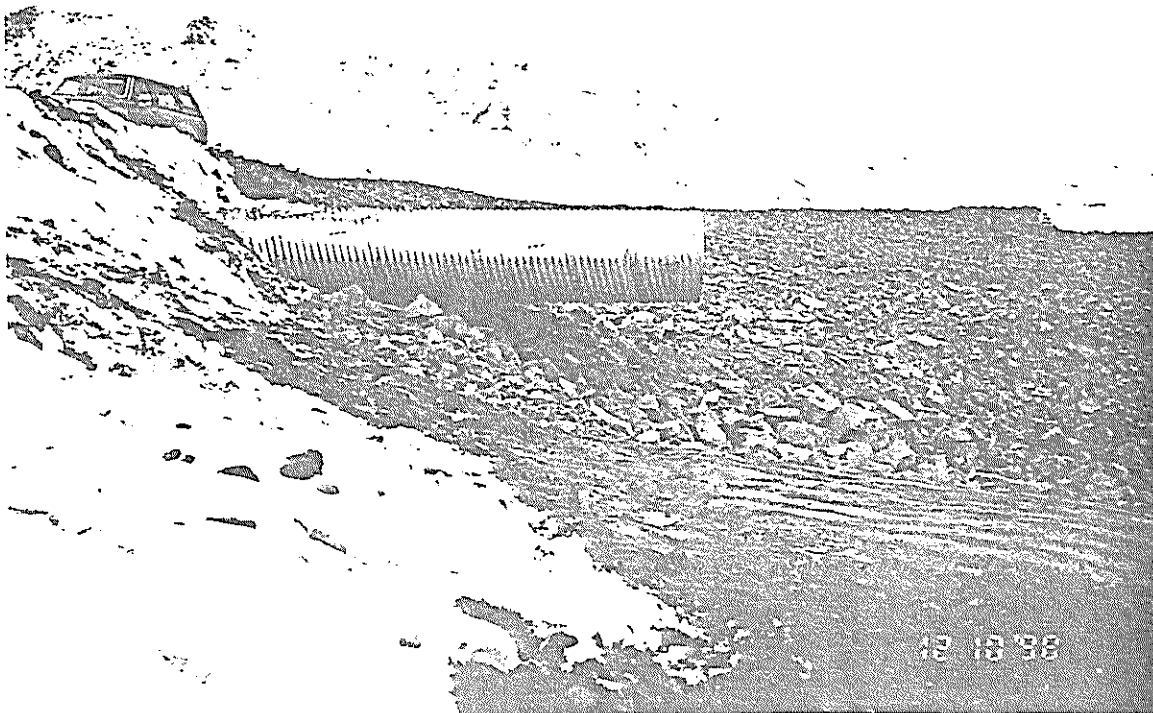


Photo 6 - Elevation view of culvert outlet.

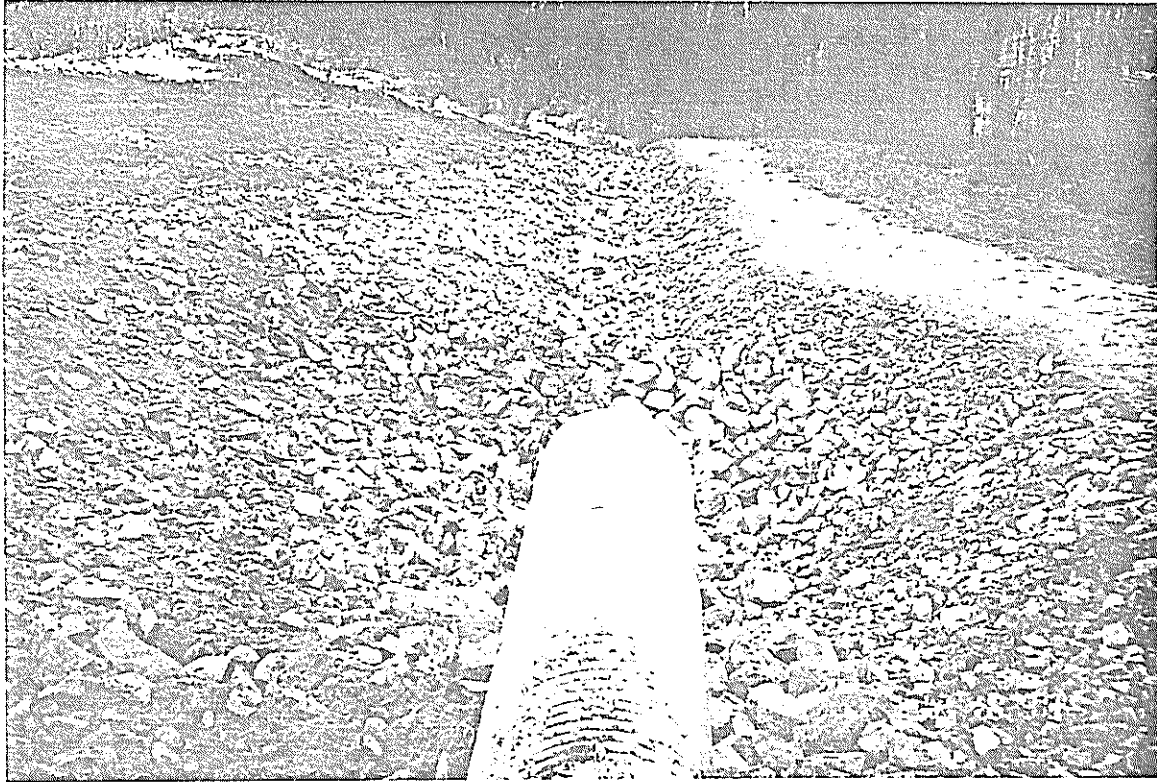


Photo 7 - View from dam over culvert outlet and plunge pool.

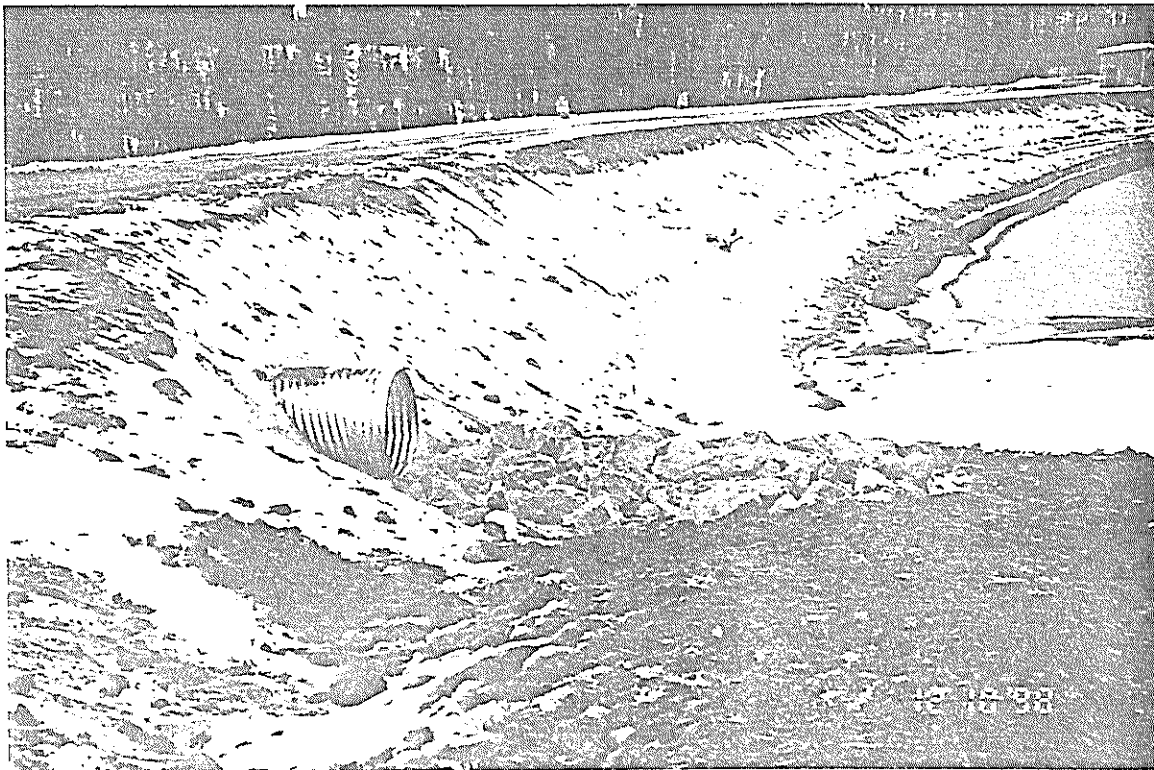


Photo 8 - Inlet of culvert spillway.

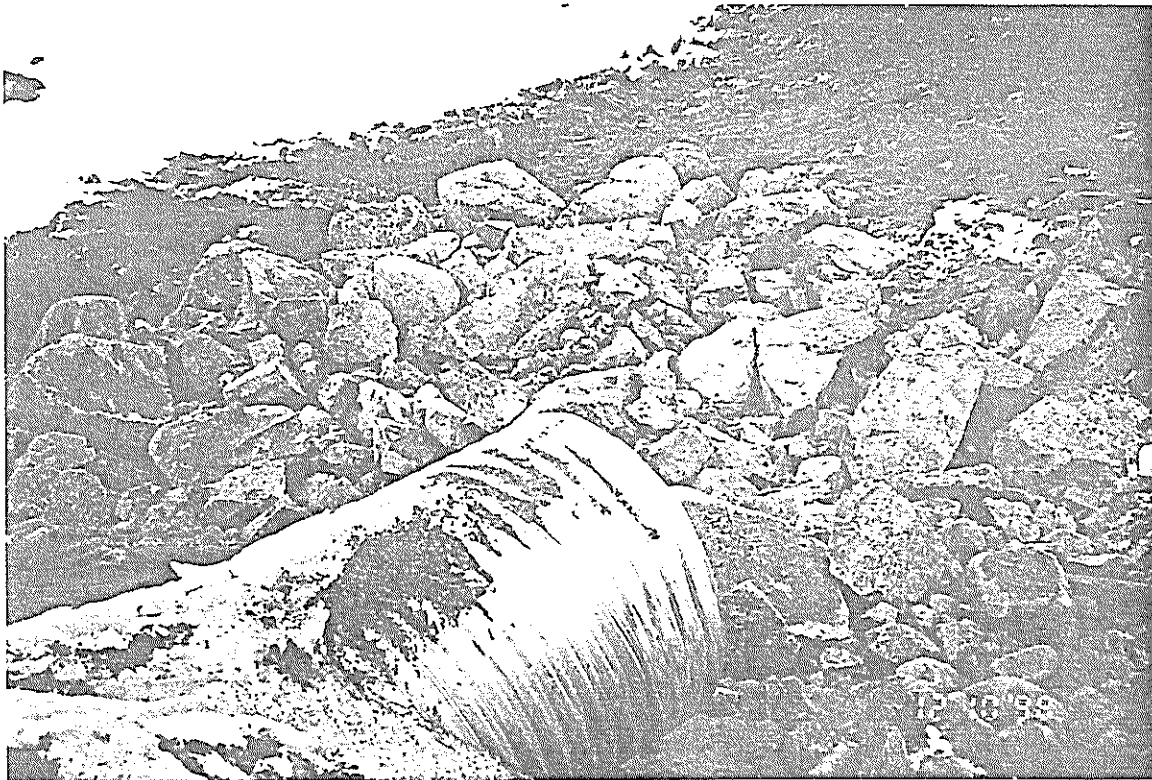


Photo 9 - Inlet to spillway



Photo 10 - View looking across at spillway with Little Creek pond to the left.



Photo 11 - View of pumphouse on Little Creek Dam

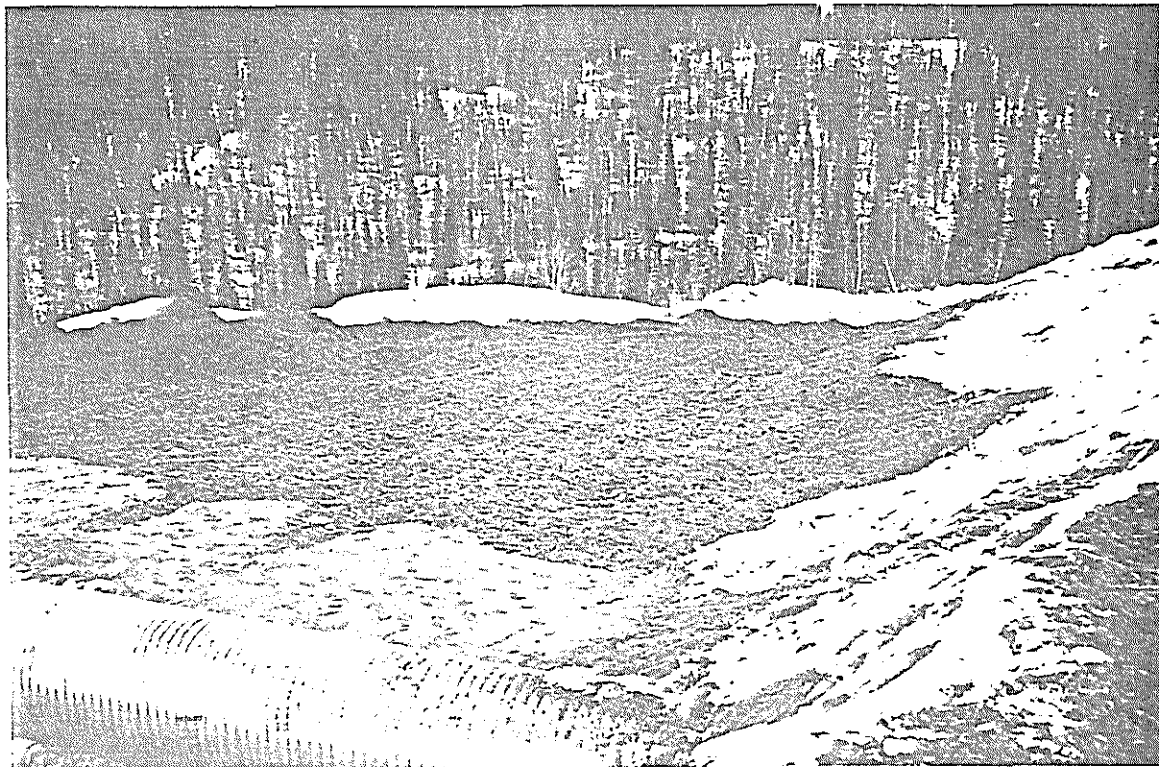


Photo 12 - Regraded area below culvert.

APPENDIX A

Design Drawings

