CHRISTINE O. GREGOIRE
Director

Resubmitted 6/2/89

STATE OF WASHINGTON

DEPARTMENT OF ECOLOGY

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M E M O R A N D U M

May 25, 1989

TO: Bob Kievit

THROUGH: Bob Goodman

FROM: Richard V. Heggen

SUBJECT: Transmittal of Site Inspection Report

Attached is the finalized Site Inspection Report for Martin Marietta Aluminum Inc.

A preliminary HRS scoring for the shallow aquifer of this site was performed on the basis of an observed release of hazardous contaminants to ground water. As no connection could be established between the shallow aquifer and any nearby population or other ground water use, even with an observed release to surface water, the resulting HRS score is only 7.36.

A preliminary HRS scoring for the deep aquifer of this site was also performed on the the basis of an observed release to ground water. The resulting score is 35.0, assuming a hydraulic connection between the deep aquifer tapped by the aluminum plant drinking water well and the contaminated deep aquifer, as well as an assumed observed release to surface water.

Due to the lack of sufficient documentation relating to aquifer connections and the extent of the release of hazardous constituents in all environmental pathways at the site, a Listing Site Inspection (LSI) is recomended in order to more fully characterize the site for HRS II scoring.

Copies of the HRS score sheets are also attatched.

RVH:BG:MJS:dh
Attachments

SITE INSPECTION REPORT

MARTIN MARIETTA ALUMINUM, INC. (11/71 - 1/85)

Commonwealth Aluminum (1/85 - 2/87)
Columbia Aluminum (8/87 - present)

GOLDENDALE, KLICKITAT COUNTY, WASHINGTON

WAD990828642

1989

Hazardous Waste Cleanup Program

PRELIMINARY ASSESSMENT / SITE INSPECTION UNIT

State of Washington

Booth Gardner
Governor

Department of Ecology

Christine O. Gregiore
Director

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Report Prepared by:

Richard V. Heggen
Washington State Department of Ecology
Preliminary Assessment/Site Inspection Unit
Hazardous Waste Investigations and Cleanup Program

SITE NAME/ADDRESS

Martin Marietta Aluminum, Inc. (Now Columbia Aluminum)
85 John Day Dam Road
Goldendale, WA 98620

INVESTIGATION PARTICIPANTS

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PRINCIPAL SITE CONTACT

Fred Rufner	Columbia Aluminum 85 John Day Dam Road Goldendale, WA 98620 (509) 773-5811

DATE OF SITE INSPECTION

November 10, 1988

INTRODUCTION

The Martin Marietta Aluminum, Inc. site, Goldendale, Washington (hereinafter referred to as site), has been identified by the U.S. Environmental Protection Agency (EPA) Region X and the Washington State Department of Ecology (Ecology) as requiring additional information to accurately profile the nature and extent of past waste disposal activities.

The Potential Hazardous Waste Site Preliminary Assessment (PA) of September 14, 1987 recommended that a Site Inspection (SI) be performed to determine if any contamination by hazardous constituents has occurred due to past disposal practices on-site. The Superfund Amendments and Reauthorization Act of 1986 (SARA) maintains the original goal of an SI: the step in the site evaluation process during which field investigators collect the data necessary to support an EPA decision as to whether to place a site on the list of those that pose the most serious threats to public health and the environment and that appear to warrant remedial action (i.e., the National Priorities List (NPL)). SIs will continue to be designed as limited, essentially one-time sampling events; they will not become extent-of-contamination studies or full-scale risk assessments.

The subsequent inspection, carried out under the Superfund Multi-Site Cooperative Agreement PA/SI Program, is described in this report, along with further recommendations, under the following sections:

1.0 Site Owner/Operator
2.0 Site History and Background
3.0 Environmental Setting
    3.1 Climate
    3.2 Geology/Hydrology
    3.3 Topography and Drainage
    3.4 Ground Water and Surface Water Uses
4.0 Ecology Site Inspection
5.0 Results and Discussion
6.0 Conclusions and Recommendations
7.0 References

Appendix A: Correspondence/Historical Data
Appendix B: EPA Site Inspection Report Form
Appendix C: Photographic Documentation

1.0 SITE OWNER/OPERATOR

The site was originally owned by Harvey Aluminum and was sold to Martin Marietta Aluminum Inc. in 1969, prior to construction of the aluminum plant. Martin Marietta operated the facility from November 1971 to January 1985. Commonwealth Aluminum took over operation of the facility from January 1985 to February 1987, at which time the plant closed. The aluminum plant was re-opened by Columbia Aluminum in August, 1987 and is currently operating under the same ownership. A portion of the site, adjacent to the Columbia River, is owned by the Corps of Engineers and leased to Columbia Aluminum (6)

2.0 SITE HISTORY/BACKGROUND

The production of aluminum at the site, located on a 7,000 acre parcel of land approximately 9 miles south of Goldendale, Washington, began in 1971. Alumina ore is refined into aluminum ingots using a modified vertical stud Soderberg process (21). This process dissolves alumina (Al_2O_3) in a fused, molten mixture of fluoride salts (electrolyte) using about five volts per reduction cell and about 110,000 amperes of electricity (7). The electrical energy is applied to each cell (pot) containing the molten mixture through the sacrificial carbon anode, located on top of the cell. Electricity exits the cell through the carbon cathode (potliner) and the steel collector bars (figure 19) at the bottom of the cell. The energy is then transfered to the anode of the next cell, i.e., the cells are connected in series. The Columbia Smelter operates over 500 cells in their pot lines (12). A potline consists of up to 200 cells connected electrically with a total line voltage of up to 1000 volts (7).

The anode, which is slowly consumed in the process at a rate of half a pound for each pound of aluminum produced, is composed of coal tar pitch, petroleum pitch (napthalene) and coke. Molten aluminum separates out at the bottom of the cell with the fluoride salts floating on top. The electrolyte consists of cryolite (sodium-aluminum fluoride), fluorospar (calcium fluoride), magnesium fluorides and lithium fluorides (21). The facility produces 490 tons of aluminum each day and operates 24 hours/ day nonstop all year (14).

Gases and particulates produced during anode production and the smelting and casting process are trapped by air stream scrubber systems. The trapped pollutants present in the scrubber waste water bleed streams include the following: fluoride, alumina, magnesium, calcium, lithium, sodium, sulfur dioxide, silver, zinc, thallium, chloride, potassium, manganese, strontium, arsenic, chromium, lead, cadmium, selenium, vanadium, copper, nickel, iron and silica. Also present are the following organic compounds: pyrenes, anthracene, benzo (a) anthracene, fluoranthene, benzo (b) fluoranthene, benzo (g,h,i) perylene, phenanthrene, chrysene, napthalene, phenols, and cyanide (21). Analyses of the scrubber system waste water stream and resulting sludge are found in tables 2-4.

From 1971 to 1978 the primary air stream was passed through wet electrostatic precipitator scrubbers to trap the gases and particulates in a primary effluent waste stream. Air escaping from the primary system into the smelter building was captured in a secondary scrubber system and treated in a similar fashion. The primary scrubber effluent stream was combined with effluent from the cast house wet electrostatic precipitator and discharged into what was later to be known as the National Polutant Disposal and Elimination System (NPDES) "A" and "B" ponds (see figure 6) (14). Prior to issuing an NPDES permit in 1974, a state waste water discarge permit was in effect (12). The outfall from the NPDES "A" and "B" ponds was combined with the aluminum plant industrial drainage (cooling water, storm run-off and treated sewage) and the secondary smelter scrubber effluent stream at a point below "B" pond. The combined waste stream continued downhill following a natural drainage course over broken basalt into a natural depression lined with gravel, which was later (1972 - 1973) diked into "C" and "D" ponds (14). The waste stream continued out of "D" pond through a steel pipe to a dispersion network in the Columbia River located 250 feet offshore at a depth of 30 feet (21).

In 1973 NPDES "A" pond filled up with waste material which was removed and placed in an unlined natural depression which was to become the East Surface Impoundment (ESI). This occurred several more times until 1978 when the primary smelter air stream treatment system was modified. The new system consisted of a Flakt dry air scrubber followed by a Flakt wet sulfur dioxide scrubber. The air stream was trapped using hoods and ducting and initialy routed through a multi-clone/ cyclone system to remove large particulates. It then passed through a reaction chamber where alumina was injected to react with gaseous fluorides producing a chemi-sorbed alumina. A third stage baghouse removed the alumina particulate which was recycled back into the smelting process. Stage four consisted of a wet sulfur dioxide scrubber to which sodium hydroxide was added to the air stream. The sulfur oxide gases reacted with sodium hydroxide to produce a sodium sulfate precipitate. The waste water stream created by this new primary system was routed into the ESI (14,21).

The secondary air collection system was also modified in 1978. Calcium chloride, caustic and flocculent were added to the wet scrubber system to react with captured fluorides and sulfur oxides to form calcium fluoride and calcium sulfate. This treated waste stream, together with effluent from the cast house, was routed through the NPDES "A" and "B" pond system into the Columbia River (14,21).

A sampling program was initiated in 1982 to study pollutants including fluoride, heavy metals, polynuclear aromatic hydrocarbons (PAHs) and chlorinated pesticides in the Columbia River adjacent to the John Day Dam. The project was sponsored by the U.S. Army Corps of

Engineers (Corps) and the National Marine Fisheries Service (NMFS) in an effort to determine the cause of abnormal delays in the passage of salmon at the fish ladders located next to the dam. The project continued, focusing on fluoride pollution, until 1986 when a final report was completed. Several follow-up samplings for fluoride were conducted by NMFS in 1988 (2,21).

In 1983, after the addition of a third smelter line, the aluminum plant waste water treatment system was modified in order to meet more stringent discharge limits. The third smelter line had an independent primary and secondary air scrubber system installed. A new 18 feet deep, 10 acre, lined evaporation pond was constructed, called the West Surface Impoundment, (WSI). During this same time period (1983) a clarifier and a tertiary treatment system were installed to clean up the secondary smelter air scrubber waste stream flowing into the Columbia River. The 130 foot diameter clarifier concentrated the effluent from the smelter secondary scrubber systems and recycled most of the process water back to the secondary scrubbers. A concentrated slurry bleed stream of 40 to 100 gallons per minute continued on to the tertiary treatment system where further particulate, hydrocarbon and fluoride removal occurred. The treated water continued on to the NPDES pond system, while the trapped pollutants were concentrated in a 20 gallon per minute (gpm) slurry and routed together with effluent from the third smelter line primary scrubber system into the WSI. Effluent from the primary air scrubbers for smelter lines one and two continued to be routed to the ESI. This resulted in a substantial reduction of fluoride emissions into the Columbia River (14,21).

In June 1985 the ESI was removed from service and the primary scrubber effluent from smelter lines one and two was re-routed to the WSI. Closure plans for the ESI were initiated in 1985 and finalized in 1987 in accordance with state dangerous waste guidelines. The final ESI cover consisted of a 50 mil hypalon barrier under a geotextile layer covered by rock. Under the plan a network of ground water monitoring wells were installed around the ESI and borings of the ESI sludge were taken and analyzed. Groundwater sampling of designated ESI monitoring wells began in 1985 and will continue until at least 2017 (21).

In 1986 the initial cyclone stage of the primary smelter scrubber system was eliminated. Previously, dry particulates removed from the primary gas stream by this stage were added to the surface impoundment waste stream, at a rate of 1,140 tons/year. Removal of the initial cyclone stage allowed these dry particulates to be trapped by the reaction chamber stage along with injected alumina. This captured material is now recycled back into the smelting process. Removal of this material from the waste stream could allow the dangerous waste designation for the WSI influent to be eliminated, although this matter is still under review by Ecology (14).

In 1984, as part of the Groundwater Quality Assessment Program (GWQAP) required by WAC 173-303-400 (3)(a), monitoring wells were installed to analyze groundwater near the WSI. Sampling began in 1984 and will continue until 30 years after closure of the WSI. The present operator, Columbia Aluminum, estimates the date of closure for the WSI to be approximately April, 1998. At that time the WSI will have filled to a point where it will no longer be able to hold any more material (21).

In 1985-86 a sediment and water quality survey of the NPDES ponds and nearby Columbia River was conducted by J-U-B Engineers Inc. at the request of Ecology's Industrial Section in accordance with condition S-4(i) of the NPDES permit. River water and sediments, as well as NPDES pond sediments, were analyzed for some priority pollutant metals, PAHs and fluoride. The survey indicated the NPDES pond sediments contained up to two percent PAHs (11). This survey was in part prompted by the preliminary findings of the 1982 - 1986 Corps/NMFS salmon delay study which indicated PAH levels as high as 16,000 ppb in Columbia River sediment at one sampling station located near the aluminum plant (2).

In 1986 the anode paste plant cooling water was re-routed from the NPDES ponds to a recycling system within the plant to eliminate PAHs from the NPDES system. As a result, PAHs are now removed from the cooling water and emitted to the outside air. This has created another problem since PAHs are heavy, water insoluble, compounds and are condensing on the roof of the paste plant building in the form of a tar-like coating (12). Ecology's Industrial Section is currently analyzing the situation. In 1988 Ecology conducted a survey of aluminum plant PAH air emissions in Washington state. The three aluminum reduction facilities using Soderberg anodes had the highest levels of PAH emissions. Columbia Aluminum emitted 83.63 pounds/hour at the time of the survey (12,21,23). The majority of PAH emissions are from the cell buildings with some contribution from the baghouse and anode paste plant building (see figures 16 and 17).

When the aluminum plant began operating in 1970, air emissions were regulated through a state regulatory order. Since 1978 air emissions have been regulated through a federal PSD (Prevention of Significant Deterioration) permitting process and state WACs. Under the current monitoring program, ambient air is continuously monitored at locations two miles downwind (east) and one mile upwind (west) (12). The aluminum plant has a history of air quality violations due to seasonal shutdowns of the air scrubber system. The air scrubber water pipes are subject to freezing during extremely cold weather and are drained to prevent major damage from occurring. The air scrubber system is shut down, on the average, about ten days each year (14). Routine maintenance accounts for four of the ten days and affects only the sulfur dioxide system. Shutdowns have sometimes resulted in penalties being assessed against site operators for exceeding state air emissions standards (12,21).

Another potential source of pollutants at the site are the carbon lined cathode cells (potliners) which contain the molten aluminum and fluoride salt mixture used during the smelting process. The average life of a potliner is about five years before heat stress and absorption of chemicals necessitate replacement. At full production, the aluminum plant would replace approximately 105 spent potliners (SPL) each year. SPL are taken to one of the two soaking stations, located near the east end of the plant, where they are showered with water containing hypochlorite to oxidize cyanide into cyanate and to soften the carbon prior to dismantling with a jack hammer. Each SPL contains cyanide as a result of the combination of nitrogen, present in the cell atmosphere, with carbon in the potliner (14). Prior to 1982, EPA inspectors reported that back-up in the closed loop shower catch basin system may have caused some overflow to the surrounding ground (4). Inspections by Ecology's Industrial Section have not noted any overflow problems since that time (12). Recently, Columbia Aluminum eliminated the SPL soaking process and, in the future, will remove the SPL material dry (12).

Dismantled SPL, together with asbestos, used to insulate potliner shells, was stored on a cement pad, located southeast of the soaking stations. By August 1982, the SPL storage pad was filled to capacity and material was overflowing on to the ground adjacent to the pad. In late 1984, a second storage pad, located near the WSI, was constructed and all material from the old pad was moved to the new SPL pad. The new pad was equiped with a containment ditch designed to route water run-off into the WSI. On March 15, 1987 the second pad reached its storage capacity of between 110,000 to 120,000 tons of SPL and was recently covered and closed in accordance with state solid waste regulations (WAC 173-304). SPL generated after that time has been stored in a SPL storage building located northwest of the smelter plant. In January 1989, the SPL storage building was filled to capacity (over 14,000 tons) and will be managed according to state solid waste guidelines. SPL generated in the future will be stored in a yet to be constructed building in accordance with state hazardous waste regulations (4,14).

On August 17, 1982, samples of SPL material were collected at the site by Ecology Industrial Section as part of a statewide survey of aluminum reduction facilities in order to classify SPL at each facility. The samples were analyzed for cyanide, chloride, fluoride and EP toxicity metals (EP Tox). Fish bioassays were also conducted, and on the basis of the above results, SPL material at the site was not designated as dangerous waste (DW) or extremely hazardous waste (EHW). In April of 1983 additional sampling of SPL material was requested by Ecology, however the tests conducted by Martin Marietta failed to comply with the approved sampling program. Tests were eventually redone and in 1985-1986 Ecology determined not to classify SPL at the site as DW. SPL at the site remains a solid waste. In September 1988 the EPA classified SPL as a hazardous waste. Washington State has until June 1990 to list SPL as hazardous waste.

Until that time, unless a new designation is issued, SPL at the site will remain a solid waste (12,14,21).

On September 14, 1987, a PA was completed with a medium priority recommendation for a follow-up site inspection. The PA also recommended continued review and monitoring of the site and that it be determined if the WSI sludge is an EPA or State toxic or dangerous waste.

A Phase I SI was conducted by Ecology on November 10, 1988.

3.0 ENVIRONMENTAL SETTING

The Martin Marietta Aluminum Inc. site is located in the Columbia River Gorge approximately nine miles southeast of the city of Goldendale in Klickitat County, Washington (16). The site is situated in sections 20 and 21, Township 3 North, Range 17 West, Willamette Meridian at a latitude of 45‘43’57" north and a longitude of 120‘04’40" west (19).

3.1 CLIMATE

The site is located in a zone of climatic transition between the moist weather conditions prevalent west of the cascade mountains and the semi-arid conditions found east of the cascades. This area is normally warm and dry due to its low elevation and location east of a gap through the Cascade Range created by the Columbia River. Constant high winds are typical of the Columbia Gorge (21). Wind direction is typically out of the west from April through September and, after air passes through the gap, it expands and is able to absorb moisture creating the dry conditions found at the site during the warmer months (13,21). Easterly winds prevail from October through March reversing the climatic conditions during this period (13). Mean annual precipitation at the site is about 13 inches with a mean annual potential evapotranspiration of about 27 inches giving a net annual precipitation of minus 14 inches (13,20). Most of the precipitation falls during the winter months (see figure 7). The two year 24 hour rainfall is less than 1.5 inches. Temperatures at Goldendale, located about 9 miles northwest of the site, range from 100 F in August to -7 F in December. Average monthly temperatures range from 66.8 F in July to 27.5 F in December with an annual average temperature of 46.5 F (13).

3.2 GEOLOGY/HYDROLOGY

The site is adjacent to the Columbia River along the southern border of Washington. It is located within the Columbia Plateau, a topographic basin bounded by the Cascade Mountains to the west and the Rocky Mountains to the east (21).

The oldest exposed rocks in the general area consist of a thick sequence of conformably layered Miocene lava flows collectively called the Columbia River Group. These lava flows reach a thickness of at least 11,000 feet near Hanford, Washington and are 730 feet thick in the Columbia River Gorge. They cover approximately 50,000 square miles of Washington, Oregon and Idaho. Individual flows are 80 to 100 feet thick with a few flows more than 300 feet thick (21).

Overlaying the Columbia River basalt is a deposit of volcanic debris and other sedimentary material varying in thickness. This Pliocene Age deposit is called the Dalles Formation but is also known as the Ellensburg Formation in Washington (21).

Bedrock exposed at the site is from a formation known as Grande Ronde basalt. This basalt is derived from an undetermined number of flows in the Columbia Plateau which commonly outcrop as massive flows 100 to 200 feet thick. Grande Ronde basalt is often capped by thick vesicular flows (21).

Directly overlying the Grande Ronde basalt is a sedimentary interbed, called the Vantage interbed, consisting of mostly well sorted fine-grained micaceous and tuffaceous sands. Vantage interbed exposures at the site are found at an elevation of about 1400 feet. Resting directly upon the Vantage interbed is a group of lava flows called the Wanapum Basalt (21).

Unconsolidated sedimentary deposits found in the area are of the Quaternary Age and consist of gravel, sand and silt laid down by the Columbia River when it was swollen by glacial meltwater. Much of this material was swept away during the prehistoric Spokane Flood, when the Columbia River was 80 times larger than the present day Mississippi River. The remaining glaciofluvial gravel is found on rock benches along the Columbia River while deposits of silt, sand and clay occur mostly in protected side valleys (21).

The site, situated approximately 235 feet above the Columbia River (Lake Umatilla), is located on a broad bench known as the Goodnoe Hills. This bench is part of the down-thrown block of the Goldendale Fault which was eroded by glaciofluvial meltwater at the end of the last North American ice age (9,21). It is characterized by erosional channels cut into the exposed basalt surface. Directly north of the site the up-thrown block of the fault is seen as a series of steep cliffs rising to an elevation of over 3,000 feet (figure 3) (9,19).

Hydrology of the area surrounding the site will be limited to the the Washington side (north) of the Columbia River. If it is found that contaminants in the ground water have reached the river, then further research may be needed to determine if the river is a barrier or if there is a hydraulic connection between both sides of the river.

The Klickitat Valley, to the north, is about 1,500 feet higher than the site. Goldendale is located in the valley about nine miles northwest of the site (16-19). Wells in the vicinity of Goldendale obtain water from interflow zones of the Columbia River Group basalt formation. Most domestic wells in the Goldendale area are approximately 200 to 300 feet deep. Agricultural wells are about 500 feet deep and typically produce 500 gallons/minute (21). Ground water elevation data from this area suggests that there may be a hydraulic connection between aquifers of the Columbia Plateau and the site through fractured conduits or bedding planes (21). This connection or flow of groundwater towards the site from the higher elevation aquifers is further evidenced by the occurrence of springs near the base of the exposed and erroded face of the Goldendale fault adjacent to the site.(9,19)

An analysis of the site hydrology beneath the ESI was conducted as part of the Ground Water Quality Assessment Program (GWQAP) 1985 Plan, required by Ecology. Mention was made of five aquifers below the colluvial water bearing zone. Potentiometric maps were produced for the coluvial zone and the top two aquifers which indicate groundwater in these zones generaly flows south, towards the Columbia River (21).

Although the direction of ground water flow for the third, fourth and fifth aquifers has not been established, static water levels recorded for the ESI monitoring wells indicate a hydraulic connection to the Columbia River and the two deepest aquifers (9). Static water levels for monitoring well numbers IB-8, IB-13 and IB-13a (representing the two deepest aquifers) are about 265 feet mean sea level (msl), which is the normal pool elevation of Lake Umatilla; the river backwater lake created by the John Day Dam. In attempting to pump out well IB-8, prior to video documentation, contractors discovered that the well could not be drawn down below the 265 foot level (21). This further substantiates a connection between the deeper site aquifers and the Columbia River (9). Static water level for the aluminum plant drinking water well number 2 (1,128 feet deep) is about 252 feet msl. This well is located approximately one mile west of the ESI which suggests the dam influences the deep aquifers under much of the site. Army Corps of Engineers wells #1 and #3 are located a few hundred feet southwest of the north end of the dam and have static water levels of 126 feet msl and 146 feet MSL respectively. These levels are just below the normal pool elevation (160 feet msl) for Lake Celilo which is situated downstream from the dam. This suggests the dam also influences the local hydrology (9).

ESI monitoring well video logs show the presence of horizontal and vertical fractures in the basalt which would allow for horizontal and downward migration of water from the upper aquifers (9,21). Porosity of basalt is typically 5 to 10 percent. At best, a few percent would be added for the water holding ability of fractures which is far below the 30 percent porosity figure stated in the GWQAP 1985 plan (9,21). Since the porosity is low, it would not hinder the migration of ground water at the site (9).

Ground water comes in contact with the ESI approximately five months each year, during the wet season (21). This would allow for the transport of soluble constituents of the ESI sludge through fractured basalt underlying the ESI (9). Probable evidence of this transport process is visible in low lying depressions or intermittent ponds, located below the ESI, which have accumulations of a material appearing not to be natural in origin (21,24). Several of these depressions were inspected during the November 10, 1988 SI. The observed material was a thick, dark, sludge-like substance with a metallic odor. One depression had a light gray discoloration of the ground a few feet higher than the material at the bottom, indicating a fluctuating water level.

Another indication of ground water migration is in the form of water seeps located south of the ESI along the basalt cliffs above the Columbia River. A few of the seeps have discolored the cliff face with a white precipitate which has been analyzed and found to contain 113 parts per million (ppm) fluoride (21). This is in excess of the typical background level for fluoride in the regional ground water (0.2 to 0.8 ppm), suggesting migration of soluble sludge material from groundwater in contact with the ESI.

Analysis of ESI monitoring well water samples indicates migration of ESI pollutants has occurred in all water levels. Static water levels for these wells seem to be grouped in two ranges: 265 feet msl for the two deep wells and between 487 to 515 feet msl for the remaining wells. Contamination of the shallow and deep aquifers by pollutants found in the ESI provides further evidence that the fractured basalt formation beneath the site provides hydraulic connections between these aquifers.

The WSI, situated at an elevation of about 450 feet, is located about one mile southwest of the ESI, which has an elevation of about 510 feet (19,24). There are six monitoring wells located near the WSI at surface elevations of between 420 and 500 feet (19,21). Static water levels for these wells vary from 379 feet to 435 feet MSL (see table 6). The GWQAP outline for the WSI mentions the existence of three water bearing zones beneath the vicinity surrounding the WSI. The upper zone occurs south of the

WSI and is a very minor perched layer, just below the basalt/colluvium contact. The middle zone is the first significant water bearing zone and occurs in the fracture zone of the uppermost basalt layer at elevations between 345 and 365 feet. The lower zone occurs in a basalt fracture zone at elevations between 275 and 280 feet. Ground water flow is reported to be generally to the west (21). Installation of from three to six additional monitoring wells near the WSI is scheduled for Spring, 1989 to gain a better understanding of the WSI hydrology (14).

3.3 TOPOGRAPHY and DRAINAGE

The site is located in south-central Klickitat County, adjacent to the Columbia River, between the Rock Creek and Klickitat River drainage basins. It is situated on a bench of land at an elevation of between 460 to 500 feet msl. Immediately to the north of the site the Columbia Hills rise up to an elevation of 3,000 feet. Farther to the north these hills slope down to a level area with an elevation of about 2,000 feet called the Klickitat Valley. John Day Dam, located almost one mile south of the site on the Columbia River, maintains a normal upstream pool level of 265 feet msl while the normal pool level immediately downstream is 160 feet msl (17,18,19).

The general direction of drainage at the site is southeast toward the river. The aluminum plant was built over two natural drainage pathways, both of which emptied into a horseshoe shaped lagoon located at the base of the hill upon which the plant rests.(19) The lagoon is separated from the Columbia River by a railroad dike and has a public boat launch on its shore. A large culvert provides access to the river for boaters and is the only direct connection between the lagoon and the river (6). The northernmost drainage was rerouted at the time the aluminum plant was constructed to accommodate wastewater and storm run-off from the facility as described in Section 2.0 (19,21,24). This altered drainage channel was separated into settling ponds (NPDES ponds A,B,C,D) with an outfall terminating by way of an underwater dispersionary network, located 2,000 feet upriver from the lagoon (21).

3.4 GROUND WATER and SURFACE WATER USES

There are seven industrial wells and nine domestic wells within three miles of the site serving a population of 760 (3,4,15,17,18,19). Three of the industrial wells are located at the John Day Dam and operated by the Army Corps of Engineers. Well number 3, located on the north end of the dam, supplies potable water for about 140 employees at the dam and about 100 tourists/day duing peak tourist season. This well is 779 feet deep with a static water level of 146 feet msl. The other two Corps wells are presently not in use (6,21). Table 1 summarizes well depth information for the industrial and monitoring wells in the vicinity of the site.

The other four industrial wells are located on the site and operated by Columbia Aluminum. Only well number 1 is used to routinely supply potable water to approximately 620 aluminum plant employees (14). It is 1,128 feet deep with a static water level of 252 feet msl and located near the southwest end of the cell buildings. Well number 3, which is 504 feet deep with a static water level of 222 feet msl, is used only when well number 1 is out of service. It is located about 1,000 feet southwest of well number 1. The other two Columbia Aluminum wells are not used (14,19,21).

Three of the estimated nine domestic wells, located within three miles of the site, lie along the same bench of land as the aluminum plant and are situated over two miles southwest (downstream) of the ESI at a higher surface elevation; approximately 1,000 feet msl (14,19). The closest upstream private well, on the same bench of land as the site, is located about one mile to the northeast. This well is at a surface elevation of about 560 feet msl and was drilled to a depth of 42 feet (4,19). All of these private wells are upgradient in relation to the site (19, 21).

Located about one mile southwest of the site, below the John Day Dam on the north shore of the Columbia River, is a small primitive public campground operated by the Army Corps of Engineers. Spring water is piped to a free flowing outlet located about 1,000 feet east of the campground The spring, originally used to supply water to railroad steam engines, is located in a cliff face a few hundred feet above the railroad tracks north of the campground. The outlet is posted "no drinking water" (see photo appendix c) due to past problems with fecal coliform contamination (6). The pipe leading from the spring has been damaged in the past and there are stock animals grazing nearby, therefore the Corps felt they could not guarantee the quality of the water for drinking purposes (6). The spring is monitored yearly by Columbia Aluminum and Ecology for fluoride (12,21). Columbia Aluminum also monitors the spring each year for cyanide (14).

Columbia Aluminum pumps surface water from an embayment below the site on the Washington side of the Columbia River. This water is used as cooling water and process water at the aluminum plant, but not for drinking. Located just below the John Day Dam, on the Oregon side of the Columbia, is a surface water withdrawal operated by the Corps of Engineers for the purpose of watering the vegetation at a Corps-owned park. This water is not used for livestock or crop irrigation. About six miles downstream, between the Biggs Bridge and Maryhill, water is pumped from the Columbia River to irrigate fields and crops in Washington (6). There are no other known surface water withdrawals within three miles of the site (4,6,14).

The Columbia River serves as a migration route for salmon traveling to upstream spawning grounds. Approximately 299,600 Coho and Sockey salmon pass through the fish ladder at John Day Dam each year based on a ten-year average (25).

4.0 ECOLOGY SITE INSPECTION

On November 10, 1988 at 10:30 AM, Michael J. Spencer and I met with Ted Mix (Ecology Industrial Section) and Fred Rufner (Columbia Aluminum) at the site. The weather was overcast with a few light rain showers. The temperature was approximately 45 degrees fahrenheit. We discussed the role of PA/SI as it relates to Columbia Aluminum. We also discussed several details in the PA file. Fred was concerned about inaccuracies relating to the reporting of PCBs in the ESI based on heresay from a note in the PA file as well as an incorrect date of cover for the ESI. These concerns were addressed in a November 18, 1988 letter to Fred Rufner (see appendix A).

The basic aluminum smelting process was discussed and new monitoring well sample analysis was presented to Ted Mix. We then proceeded to tour the site, beginning at the old open SPL storage area, which is no longer used for SPL storage. It is temporarily being used to store pot bottoms, which consist of material (mostly aluminum) left over in the bottom of the pot liners.

The next stop was at the two potliner soaking stations, where the SPL is soaked in a chemical solution to remove cyanide. This appeared to be a self contained operation. We then prodeeded to the new SPL storage building. There was a distinct metallic-ammonia odor in the building coming from the SPL as a result of chemicals present in the SPL. The SPL consisted of large chunks of carbon and brick matrix broken out of the potliner frames. This structure was completed in September 1988 and, at the time of the inspection, contained about 14,000 tons of SPL removed from service since March 15, 1987. SPL stored on site was designated as solid waste.

We then drove west to a nearby knoll to view the WSI and adjacent second SPL storage area. Closure operations were in progress at the second SPL storage area by CH2M Hill (contractors) and have since been completed (14). Heavy equipment was visible flattening the SPL prior to covering. This storage pile contains between 110,000-120,000 tons of SPL generated by Commonwealth Aluminum and Martin Marietta. The storage area is underlain with a cement slab and surrounded by a retaining wall.

The WSI, located just to the southwest of the SPL storage area, is an evaporation pond with a 30 mil hypalon lining consisting of two 15 mil liners bonded together (see section 2.0 for more information on the surface impoundments).

An abandoned drummed oil storage area, was visible between the new SPL building and the WSI. Originally drums were stored on the ground (unlined) with some spillage occurring. A cement pad was later installed for drum storage at this location. No drums were stored on this pad since a new controlled oil-drum storage area had been implemented.

On route to the ESI we stopped at the plant to observe the smelting process and potliner fabrication. Potliners were visible at nearly every stage of production, from laying of the brick base to final caulking of the seams between the carbon blocks with cold seam mix, consisting of coal tar, coke and napthalene. Rows of hundreds of electrolytic cells used to melt the alumina ore were observed. This facility uses a modified vertical stud Soderberg process to produce primary aluminum. The molten aluminum is siphoned out of each cell and transported to another section of the plant for final casting. The electrostatic forces inside the plant are great enough so that credit cards, tape recorders, watches, and cameras are not advised inside the plant due to potential damage. The plant produces 490 tons of aluminum per day and operates 24 hours/day nonstop, all year. The entire facilty is located on a 7,000 acre parcel of land.

The final stop of the inspection was the closed ESI, which is surrounded by a cyclone fence and completely covered with a liner topped with gravel. The ESI was temporarily covered with rock in response to an Ecology order (No. DE 85-526) to stop the dried sludge material from being blown off site by prevailing strong winds (4,12). We walked south, over the ESI, toward the Columbia River noting several low lying depressions containing a dark sludge. This sludge is a result of ESI sludge constituents leaching out of the ESI and migrating through the underlying fractured basalt (4). The sludge was of firm consistency and had a slight metallic odor. There was some sparse vegetation growing in the sludge showing no visible signs of stress. We proceeded to walk to the edge of a cliff overlooking the river. A boat basin created by a railroad dike is located below the facility. Springs near the boat basin contain 5 to 6 ppm fluoride. The source of the fluoride remains undetermined, although it could possibly be the ESI or a drainage ditch.

Much of the terrain surrounding the ESI consists of rock outcroppings and rocky soil with sparse vegetation. We returned to the van noting several large diameter (4 feet) wells which were dry. These wells were placed in areas of intermittent ponds which were to be cleaned up during the closure of the ESI. They were placed there as observation points to determine if the closure was effective and in case low spots needed to be pumped (12). The inspection ended at approximately 2:00 P.M.

No samples were taken during the SI since there is sufficient sample data available for the purpose of this report. Ground water from the ESI and WSI monitoring wells has been collected and analyzed since 1985 for pollutants such as cyanide and fluoride as part of a state approved monitoring plan for the site. The samples are collected quarterly or semi-annualy to be analyzed by laboratories contracted by Columbia Aluminum. The NPDES waste water system is sampled on a continual basis (24 hrs/day) and analysis is performed at the aluminum plant in-house laboratory. Some of the NPDES pollutants tested for include fluoride, metals, and pyrene. Total suspended solids (TSS) and pH are also monitored.

Stack emission sampling is conducted several times each month. Columbia Aluminum analyzes daily ambient air samples collected from stations located about two miles east (downwind) and one mile west (upwind). Forage samples are also analyzed during the growing season. Results of air emisssion and waste water sampling are sumbitted to Ecology monthly.

Ecology Industrial Section conducts an annual class-2 waste water inspection of the site as required by the NPDES permit. Samples are collected and split with Columbia Aluminum. Samples of spring water near an Army Corps of Engineers campground are also collected periodically. Ecology conducts non-sampling inspections of the site during several class-1 inspections each year. Dangerous waste inspections and an annual air emission inspection are also conducted by Ecology Industrial Section.

5.0 RESULTS AND DISCUSSION

This section will be divided into the following categories:

- A Surface Impoundment Influent and Sludge Analyses
- B Ground Water Analyses
- C Waste Water (NPDES) and Columbia River Analyses
- D Air Emissions Analyses
- E Spent Potliners

A. Surface Impoundment Influent and Sludge Analyses.

The influent to the ESI was sampled in November of 1984 and analyzed for EPA priority polutants as part of the ESI Closure Feasibility Study. Twenty-four EPA priority polutants were present in the ESI influent waste stream at levels above the detection limit (see table 2).

Samples of the ESI sludge were collected on April 22 and 23, 1985 for EP Tox, Ignitability, and Reactivity analyses. The results showed that the ESI waste was noncharacteristic and did not meet EPA criteria for toxicity, ignitabilty, or reactivity. The WSI sludge was sampled on October 31, 1985 and analyzed for the same parameters. The results indicated that the WSI sludge was not characteristic of a toxic, ignitable, reactive or corrosive waste (21). The results are on file with Ecology Industrial Section. The WSI sludge was also analyzed for EPA priority pollutants. Sixteen priority pollutants were found above the detection limit (see table 3). Sludge from the ESI was also analyzed for toxic and non-toxic constituents. A total of 36 individual components were identified (see table 4). Table 5 lists the method references for the ESI chemical analyses.

Static acute fish bioassay tests were performed by Biomed Research Laboratories on a grab sample of the ESI sludge in accordance with guidelines set forth in the State of Washington Biological Testing Methods: Ecology 80-12. The first test results, reported on April 10, 1984, indicated the sludge was toxic at the 1,000 ppm level and should be classified as DW under Ecology regulations. There was some question whether or not this sample was representative of the ESI sludge. In May of 1985 a second bioassay test was conducted on individual and composite samples of the ESI sludge. The results indicated the sludge samples were nontoxic at both the 100 ppm and 1,000 ppm level. Due to the conflicting test results, a third test was conducted on a composited sample remaining from previous round of tests. A different laboratory (JUB Engineering) analyzed this sample and reported that the ESI sludge was toxic at the 1,000 ppm level. The sludge was classified as a dangerous waste (21).

B. Ground Water Analyses

Ground water at the site has been monitored for toxic pollutants since 1984 as part of the GWQAP plan. Initially, four ESI monitoring wells were monitored for 37 parameters (see table 6). In 1985, eighteen ESI monitoring wells were analyzed for EPA priority pollutants and indicator parameters. A total of 21 pollutants were identified as outlined in table 7. Of the total, 17 were identified as ESI waste constituents as follows; nickel, potassium, total cyanide, strontium, chloride, iron, manganese, copper, thallium, sodium, calcium, zinc, nitrate, total phenols, fluoride, silver, and sulfate.

Ten of the ESI sludge constituents were found in the deeper wells (zones 4,5 and 6) as follows; total cyanide, chloride, iron, manganese, sodium, zinc, nitrate, total phenols, fluoride, and sulfate.

The ESI Post-Closure Ground Water Monitoring Program identified the following parameters for quarterly analysis: pH, specific conductance, total organic carbon (TOC), total organic halogens (TOX), fluoride, sulfate, and total cyanide. The analytical results for the last five parameters are summarized in tables 8 - 12. Additionally, the following parameters are sampled and analyzed on an annual basis: chloride, iron, manganese, sodium, and phenol. Table 13 summarizes the sample results for phenol.

The two upgradient background monitoring wells, MW-1 and IB-3 are located about 600 feet north of the ESI. These wells have static water levels of 530 and 524 feet msl, respectively, and tap into the shallow aquifers near the ESI. For the purposes of this report, they will be considered as background wells for the deeper aquifers since all aquifers at the site are hydraulically connected (9).

Fluoride was found to be in all of the monitoring wells and the aluminum plant drinking water well. The highest level of fluoride found in any of the monitoring wells was from ESI monitoring well MW-10, a shallow well located about 300 feet southeast of the ESI. Fluoride at this well was recorded between 12.8 to 15.3 mg/l which is approximately 70 times the backgound level of about 0.2 mg/l. The second highest level of fluoride found was at well IB-9, located about 600 feet south-southeast of the ESI, with readings ranging between 4.4 to 6.7 mg/l. Monitoring well IB-13, which taps into the deep aquifer, had the third highest levels of fluoride with readings ranging between 2.37 to 3.50 mg/l or about 13 times the background level. None of the WSI monitoring wells registered readings greater than about 2 times the background level (see table 8).

Sulfate is monitored as one of the indicator compounds in order to determine the pathway of pollutants from the surface impoundments. Sulfate was found in all of the monitoring wells and the aluminum plant drinking water well as summarized in table 9. The two background wells had levels of sulfate between 15 and 21 mg/l for all sampling periods except 1985. The levels in 1985 were 39 mg/l for MW-1 and 717 mg/l for IB-3 and will not be considered as typical background levels for sulfate. The highest levels of sulfate were found in the shallow ESI monitoring wells MW-10, IB-1, IB-5 and IB-9 with readings ranging between 1,750 and 15,500 mg/l. The two deep ESI monitoring wells, IB-8 and IB-13, had sulfate readings between 320 and 1,180 mg/l or between approximately 16 to 59 times the background level. Most of the ESI readings fluctuated up and down with time. The WSI monitoring wells were at background level with the exception of well MW-7B which had readings between 63 and 74 mg/l or about 3.5 times background. The aluminum plant drinking water well had a sulfate reading of 53 mg/l or about 2.5 times the background level (see table 9).

Cyanide (total cyanide) was found at levels between 109 and 303 ug/l in ESI monitoring well IB-8. The background wells were below the minimum detection level (mdl) of 5 ug/l for cyanide, therefore well IB-8 had cyanide levels from 21.8 to 60.6 times the mdl. Well IB-8 represents the deep aquifer and is located about 4,000 feet east of well-1, the aluminum plant drinking water supply (see figures 1 and 18). It has the highest levels of cyanide contamination of any of the monitoring wells, which indicates the contaminated plume is less than than 4,000 feet from the plant drinking water supply. All other ESI monitoring wells were less than 3 times the mdl for cyanide. It should also be noted that only one WSI monitoring well (MW-6B) recorded a cyanide level above the mdl. MW-6B had a reading of 14 ug/l which was also less than 3 times the mdl (see table 10).

TOX was found in all of the ESI monitoring wells, however the reading for some wells varied between the lower detection level to some measurable amount depending on the sample period. In 1985, the background wells had readings of 26 and 70 ug/l. All readings of TOX in the background wells after 1985 were either below the mdl of 10 ug/l or within 3 ug/l of the mdl. Background levels of TOX have stabilized at or below the mdl, therefore 10 ug/l will be used to compare levels of TOX. The three highest levels of TOX were found in the shallow monitoring wells, MW-10, IB-9 and IB-1. Levels of TOX for these wells were from 44 ug/l to 151 ug/l or from 4.4 to 15.1 times the mdl. The deep monitoring well, IB-8, had TOX levels ranging from 15 ug/l to 38 ug/l or from 1.5 to 3.8 times the mdl. In general, the levels of TOX in the ESI monitoring wells have been decreasing with time. The WSI monitoring wells and the aluminum plant drinking water well were not analyzed for TOX (see table 11).

TOC was found in most of site monitoring wells including the background wells. Since the background wells were also contaminated with TOX, it is suspected that the levels of TOC found in wells MW-1 and IB-3 (ranging from 0.3 mg/l to 13.4 mg/l) may not represent the true background level of TOC. Some shallow ESI monitoring wells, including MW-10, IB-5, IB-9, IB-11 and IB-1, had elevated readings of TOC during the most recent sampling periods. Readings ranged from minimum detection level (0.2 mg/l or 0.6 mg/l depending on sampling period) to 79 mg/l, about 131 times the mdl of 0.6 mg/l. The two deep ESI wells had TOC concentrations between 1.1 and 10.0 mg/l or between 1.8 and 16 times the mdl of 0.6 mg/l. The WSI monitoring wells had TOC levels between 0.4 and 1.4 mg/l. The aluminum plant drinking water had no detectable amounts of TOC (see table 12).

The ESI monitoring wells were analyzed for phenol in 1985 and in January of 1988. In 1985, using an mdl of 2 ug/l, five shallow wells were found to have levels of phenol ranging between 3 to 7 ug/l or from 1.5 to 3.5 times the mdl. The two deep wells and several of the shallow wells were not sampled. In 1988, using an mdl of 5 ug/l, only two wells were found to have detectable levels of phenol: IB-10, a shallow well, with a reading of 5 ug/l (= mdl) and IB-13, a deep well, with a reading of 7 ug/l

(1.4 X mdl). No other wells were analyzed for phenol (see table 13).

Water from the primary aluminum plant drinking water well was sampled in May of 1987 (see appendix a, November 29, 1988 letter from Rufner to Heggen) and analyzed for all of the previously mentioned quarterly parameters except phenol and TOX. Cyanide was below the mdl of 5 ug/l and TOC was below the mdl of 6 mg/l. Sulfate was 53 mg/l or about 2.7 times the background level. Fluoride was 0.54 mg/l or about 2.7 times the background level. The results, as presented in tables 8 -13, were all below the EPA maximum contaminant levels (MCLs). Table 14 lists the EPA MCL's.

In December 1988 a meeting was held between Ecology Industrial Section and previous site operators to present Ecology with a progress report on the ESI (see appendix a). Although the information in the report was intended to show a reduction of ESI pollutants in the ground water, the data provided further evidence that a plume of pollutants is moving and/or spreading. The data shows little change, if any, in the ESI water table. Specific conductivity and sulfate levels have generaly decreased in the ESI monitoring wells, however no explanations were given. It is possible that after the cover was applied, the supply of oxygen was reduced and the sulfate precipitated out in the form of iron sulfate which would account for a decrease in both sulfate and specific conductivity (9).

Fluoride levels in the vicinity of the ESI have, in general, shown a slight increase (21).

Data from four monitoring wells was used to produce several graphs in the report to show pollutant levels vs depth. IB-13, a deep well, had higher levels of fluoride than all other shallow ESI monitoring wells with the exception of MW-10 and IB-9. Fluoride levels in both of the deep ESI wells (IB-8 and IB-13) have been increasing. A graph of total organic carbon (TOC) vs depth shows that, after the ESI cover was applied, levels of TOC increased at all depths simultaneously which would indicate the zones of groundwater are in communication with the surface and each other. The increase in TOC levels when the ESI was covered may also be due to decreased availability of oxygen (9).

Ground water comes in contact with the ESI during the wet season allowing soluble ESI waste constituents to migrate into lower topographic depressions (intermittent ponds) near the ESI (21). The locations of a few of the intermittent ponds (leach ponds) are included in figure 18. The ponds fill with water during late winter and spring then dry-up during summer and fall (21). To date, sludge accumulations in the ponds have not been sampled (12). On April 7, 1989, during a site inspection by Ecology Industrial Section, water samples were collected from the intermittent ponds below the ESI. The samples are presently being analyzed for cyanide, fluoride, sulfate, and specific conductivity, although the samples may not have been properly fixed for cyanide (12).

C. Waste Water (NPDES) and Columbia River Analyses

Waste water discharge from the site consists of cooling water, storm water run-off, treated sewage, and processed air emissions scrubber water. This waste water flows through the NPDES outfall system into the Columbia River. The NPDES waste water is monitored on a continual basis (24 hours/day) by the aluminum plant and the results are submitted monthly to Ecology Industrial Section. The following parameters were monitored at the main NPDES outfall from November of 1971 to present: fluoride, total suspended solids, oil and gas, pH, temperature, flow, and production in tons/day. Beginning in July 1985, four additional parameters were added as follows: benzo (a) pyrene (BaP), tin, nickel, and aluminum. The results of the monitoring as far back as 1981 are on file at Ecology Industrial Section. Earlier monitoring results are stored in Ecology archives. Due to the large amount of information, the raw data have not been included in this report.

These records indicate daily fluoride limits have been exceeded on several occassions since 1981. The current discharge limits for fluoride are an average of 210 lbs/day over a 30 day period with a daily maximum of 485 lbs. Monthly pH limits have also been exceeded several times during the same period, however this may be due to an increase in the activity of aquatic plants found in the NPDES pond water. The acceptable pH range is between 7.0 and 9.0. (12).

Table 17 is a yearly chronology of average daily fluoride discharge from the NPDES outfall into the Columbia River. From 1972 to 1979, daily discharges of fluoride into the Columbia River averaged between 5,630 and 2,088 pounds/day. Fluoride discharges have decreased sharply since 1979, from 626 pounds/day in 1980 to approximately 127 pounds/day in 1985. Fluoride discharge rates after 1985 have been below the present 210 pounds/day (average for 30 days) NPDES limit, with the exception of September 1988 (572 pounds/day) and April 1986 (551 pounds/day).

Annual NPDES inspections are conducted at the site by Ecology's Industrial Section. These inspections involve sampling for several parameters at various locations on or near the site. Table 15 summarizes the sample analysis for the November 18, 1987 annual inspection. Table 16 summarizes the findings of additional sampling event occurring on May 21, 1987.

As part of the annual NPDES inspection, the spring water outlet located near the Army Corps of Engineers public campground is tested by Ecology for fluoride (see table 15 - WMA Spring Grab for fluoride results) (12). Columbia Aluminum tests the spring water once a year for cyanide and monthly for fluoride (12,14). No significant finds of either pollutant have been detected (14,21). The spring water outlet is posted not to be used for drinking because of past problems with fecal coliform contamination (6)(see section 3.4).

Columbia Aluminum has also tested two rivulets below the site, the boat basin, an up and down river station in the Columbia and one station in the John Day River for fluoride and pH on a monthly basis since August 1988. A few samples were collected prior to that time (May 1987 to August 1988), but not all of the stations were used (12). Figure 11 shows the location of the west rivulet as 7 creek and the east rivulet as 8 creek, both of which empty into the adjacent boat basin.

Results of the sample analyses are on file at Ecology Industrial Section. Ranges for pH readings are as follows: east rivulet = 8.0 to 8.4, west rivulet = 7.0 to 7.8. The boat basin and river station pH readings were all between 8.0 and 9.0, which is similar to pH readings from other locations on the Columbia (12).

The following is a summary of the ranges of fluoride sample analysis received to date: east rivulet = 5.5 to 8.0 ppm, west rivulet = 4.0 to 5.25 ppm, boat basin = 0.23 to 0.36 ppm, Columbia River downstream = 0.17 to 0.26 ppm, Columbia River upstream = 0.17 to 0.24 ppm, John Day River = 0.14 to 0.26 ppm (12). Fluoride readings for all of the river stations are similar to the background well readings for the ESI monitoring wells and, on the average, just slightly higher than the fluoride levels noted in May 1983 in the Damkaer and Day-Corps/NMFS report (2) (see figure 15). Using 0.2 ppm as an average background level for fluoride (based on the ESI wells), the west rivulet is from 20 to 26 times higher than background and the east rivulet is from 27 to 40 times background.

Delays in the passage of salmon at the John Day Dam prompted the Army Corps of Engineers and National Marine Fisheries Service (NMFS) to finance a study of the effects of water-borne pollutants on fish passage at the dam. Figure 14 shows the locations of the sampling stations. The final report was presented in June of 1986 and concluded that the high levels of fluoride discharged into the river prior to 1983 had a significant negative impact on the adult salmon passage time and survival over the dam. Reductions in fluoride discharge to the river in recent years have increased survival rates of the salmon at the dam (2). The report went on to conclude that the present low fluoride discharge may only be a temporary condition and that more studies are needed to determine the natural background level for fluoride in the Columbia River (see figure 15 for fluoride background levels near the site).

The report also mentioned that river sediments near the dam contained low levels of chlorinated and aromatic hydrocarbons. However, the aromatic hydrocarbon (PAH) content of some sediments close to the aluminum plant averaged about 8,000 ppm (ng/g), dry weight (see table 18,19, and figure 14). Table 20 lists the detection limits for each parameter sampled. Heavy metals have also been found in the river sediments (table 21). The effect of hydrocarbons and heavy metals on the food chain and migration of fish remains undetermined (2).

A recent report (12/88) from Ecology Toxics Investigations/Ground Water Monitoring Section noted similar contamination of Columbia River sediment at Longview, adjacent to the Reynolds Aluminum reduction plant. Sampling was conducted September 1987. PAH sediment concentrations at the Reynolds sampling station were 19,000 ng/g dry weight (24). Individual PAH compounds such as chrysene, pyrenes and anthracenes were found in similar proportions to those recorded by the Corps/NMFS study at station 10, above John Day Dam (2,24).

A report prepared by J-U-B Engineers was submitted to Ecology on February 28, 1986 in accordance with the NPDES permit. The purpose of the report was to study sediments in the lagoon (pond) system and the adjoining Columbia River to determine possible contamination from heavy metals and organic pollutants. The study also analyzed the receiving water to determine compliance outside the permittee's dilution zone. Figures 11 and 12 show the locations of the sampling stations. Figure 13 shows the extent of the visible plumes near the waste outfall.

The NPDES ponds contain a total of 38,000 cubic yards of sediments. The degree to which each pond is filled with sediment is as follows: A pond = 100 %, B pond = 38 %, C pond = 30 %, and D pond = 25 %. The pond sediments contain between 1 and 2 % PAHs which, if they were dredged, would be considered Extremely Hazardous Waste (EHW) under state regulations (11,12). Table 22 lists the water quality criteria and detection limits used for this study. Table 23 is a summary of the analytical methods utilized during the study.

A summary of the anlysis of the NPDES pond sediments is presented in table 24. Seven metals and eleven PAHs were tested for and detected.

J-U-B also analyzed Columbia River sediments for the same seven metals and eleven PAHs at five locations; 7NMFS (background), station 7.1, station 7.3, outside the boat basin, and inside the boat basin. The results are presented in table 25. Station 7.3, located about 200 feet downstream from the outfall, recorded levels of PAHs approaching those found during the Corps study (see tables 18 and 19). The levels of metal in the river sediment found by J-U-B were higher than those reported in the Corps study.

Tables 26-29 summarize the NPDES waste water effluent and river water sample analysis conducted by J-U-B. The water samples were tested for the same seven metals and eleven PAHs analyzed in the sediment samples as well as fluoride. Two of the PAH's were in compliance with the federal water quality criteria (WQC) limits. No determination could be made with the remaining PAHs since the detection levels exceeded the WQC limits. Lead was consistently above the WQC limit and the highest readings occurred in the background samples. Cadmium was detected above the WQC limit only in the background sample. Zinc was detected at the WQC limit at the 7-creek station. The remaining four metals were all within the WQC limits (11).

D. Air Emissions Analyses

Air emissions samples have been routinely collected by the aluminum facility and analyzed in-house. Monthly records are maintained at Ecology Industrial Section but were not not included in this report due to the volume of data. Ambient air is sampled for hydrogen fluoride and sulfur dioxide. The sampling stations are located as follows: station G, two miles east of the aluminum plant (downwind); station H, one mile west of the plant (upwind); station J, (discontinued 3/88) on site about 600 feet southeast of the WSI (14).

Air emissions are sampled at the primary and secondary stacks for fluoride, sulfur dioxide and particulates. Primary and secondary stack emission readings are averaged for each month and combined for a total stack emissions figure, not to exceed the following PSD standards: particulates = 8 pounds/ton of aluminum produced, fluoride = 2 pounds/ton, sulfur dioxide = 14 pounds/ton, depending on the sulfur content of the coke used during processing (standards effective since August of 1988).

Foliage samples are also analyzed and the sample stations are located as follows: station G, same as ambient air station G (downwind); station MH, about 8 miles west of the plant near Maryhill Park (upwind); station SP, about 0.5 mile west of the plant near the Columbia Aluminum property line (14).

As described in section 2.0, the air scrubber system (or a portion of the system) has been shut down for an approximate average of ten days each year sometimes resulting in violations of the state ambient air emissions standards (14). Ambient air quality standards for hydrogen fluoride (WAC 173.481) are as follows: 2.9 ug/cubic meter (average for 24 hours), 1.7 ug/cubic meter (average for 7 days), 0.84 ug/cubic meter (average for 30 days), 0.50 ug/cubic meter (average for the March 1 to October 31 growing season). Typically, air quality penalties assessed against the aluminum plant operators have been for exceeding the ambient fluoride standards. During the months of September, October and November, 1987 (the period of plant start-up), emissions exceeded the ambient fluoride limits. Readings for the 24 hour average were between 3.72 and 4.26 ug/cubic meter. Thirty day average ambient fluoride levels also exceeded the limits during October and November with readings of 2.04 and 1.50, respectively. With the exception of 1988,1986 and 1981, ambient fluoride limits have been exceeded each year (21).

No readings exceeding ambient sulfur dioxide standards have occurred at the aluminum facility (12). Washingon State ambient air quality standards for sulfur dioxide (WAC 173.474) are as follows: 0.40 ppm (average for 2 hours no more than once each year), 0.25 ppm (average for 1 hour no more than twice in a 7 day period), 0.10 ppm (average for a 1 day period no more than once each year), 0.02 ppm (average for a one year period)(12).

A special study was conducted by Ecology in 1988 to determine PAH emissions at aluminum reduction facilities in Washington State. Columbia Aluminum hired a contractor (AMTEST) to collect and analyze PAH samples from the baghouse, cell buildings, and anode building in early 1988. A resin medium was used to collect PAHs at the stacks. Samples were analyzed using acid-base neutral extraction and GC mass spectroscopy in accordance with EPA standard methods (23). The results are presented in the form of graphs in figures 16 and 17. PAH emission rates for Columbia Aluminum were 83.63 pounds/hour.

The significance of the statewide PAH emissions analysis has yet to be determined. No standards for PAH stack emissions have been established (12).

E. Spent Potliners

SPL material has been a potential source of pollutants at the site in the past as discussed in section 2.0. In 1982, Ecology sampled and tested SPL at all aluminum reduction plants in the state for cyanide, chloride, fluoride, and EP toxicity metals (tables 30,31). Static acute fish bioassays were also conducted (table 32). As a result of the tests, SPL at the site was not designated as DW.

In 1983 Ecology requested further testing of SPL in order to more accurately classify SPL. By October of 1984, Martin Marietta had failed to follow an approved sampling program. They did conduct one fish bioassay and one rat bioassay on SPL after the material had passed through the soaking station. The material failed the rat bioassay (21). Tests were eventually redone and in 1985-1986 Ecology determined not to designate SPL at the site as DW (12). The EPA designated SPL as DW in September of 1988. Washington State has until June of 1990 to adopt that designation (12). Until that time, unless a new designation is issued, SPL at the site will remain classified as a solid waste (12,14,21).

In the meanwhile, Columbia Aluminum will store and handle all SPL as if it were DW (14). Based on information in Ecology Industrial files and the December 5, 1988 SI, it appears that current SPL storage methods do not present any pathway to the environment.

6.0 CONCLUSIONS AND RECOMENDATIONS

The groundwater analyses indicate that the plume of contaminants beneath the ESI is spreading (9,21). Contaminants have reached the ESI perimeter monitoring wells, therefore the present network of monitoring wells is unable to detect the full extent of the plume. The plume appears to be spreading to the south, east and west; towards the Columbia River and aluminum plant.

The area of most immediate concern at the site is the contaminated deep aquifer which may be hydraulically connected to the aluminum plant drinking water well (well-1). To date, no information has been presented to prove that the deep aquifer is not connected to the source of the aluminum plant drinking water.

The June 1987 analyses of well-1 for fluoride, sulfate, total cyanide, and TOC indicated levels either below detection limits or below the MCLs. Analysis of the ESI monitoring wells revealed levels of cyanide in ESI well IB-8 (a deep well located about 4,000 feet east of well-1) ranging between 109 and 303 ug/l (MCL = 200 ug/l) and about 22 to 60 times the background level. The same well (IB-8) also had fluoride readings ranging from background levels up to 5 times background. The other deep monitoring well (IB-13), located about one mile east of well-1, had fluoride readings ranging between 2.37 to 3.50 mg/l or about 12 to 17 times background (MCL = 4.0 mg/l). Two shallow ESI monitoring wells, MW-10 and IB-9 (also located about one mile east of well-1), have consistently exceeded the MCL for fluoride. Readings for MW-10 ranged from 12.8 to 15.3 mg/l (64 to 76 times background) and readings for IB-9 ranged from 4.4 to 6.7 mg/l (22 to 33 times background).

The main source of ground water contamination appears to be the unlined ESI which has leached pollutants into the ground water although it remains unclear whether or not past SPL storage practices and other aluminum plant operations have contributed any pollutants (12).

A full priority pollutant scan for aluminum plant wells 1 and 3 (the drinking water back-up well) should be conducted as soon as possible to determine if pollutants, other than the four previously analyzed, have reached the plant drinking water. A quarterly monitoring program for the aluminum plant drinking water should be included in the monitoring well sampling program. It should continue unless characterization of the contaminant plume indicates no threat exists to the aluminum plant drinking water wells.

Due to the unanswered questions relating to potential or observed release of pollutants to the air, ground water, surface water and river sediments a Listing Site Inspection (LSI) is recommended in order to fully characterize the site, encompassing the following four areas:

1. Additional hydraulic tests are needed to determine the degree to which the contaminated aquifers are connected to the aluminum plant drinking water wells.

2. Further studies of Columbia River sediments are needed in order to determine if there is any affect on the environment from the PAHs or metals found in the sediment near the NPDES outfall.

3. Study of the PAH air emissions at the site should continue in an effort to discover the degree and extent of the off-site migration.

4. A full priority pollutant scan of material accumulated in the intermittent ponds is recommended to determine which pollutants are going into solution from the ESI. The sediments in the ponds are accessible to wildlife and, when dry, could become airborne (9).

Additional monitoring wells are required to fully characterize the present extent of contamination. At least one upgradient test well should be completed to the deep aquifer to be used for background ground water data. An attempt should be made to model and predict the velocity, direction and present location of the plume using existing data (9). Information gathered from the additional monitoring wells should be incorporated in the plume characterization model.

If these further characterization studies indicate further downgradient ground water contamination, Ecology recommends that the Army Corps of Engineers wells 1 and 3, on the north side of the dam, be tested for pollutants.

If the plume characterization studies indicate it is necessary, Ecology recommends the addition of pumping wells surrounding the ESI to lower ground water contact (mounding) during the wet seasons .

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TABLE 1

Well Data (feet)

Well #	Static Water Elevation *	Well Bottom Elevation *	Well Surface Elevation *	Distance From Surface to Bottom of Well
ESI upgradient monitoring wells				
MW-1	530	508	538	30
IB-3	524	497	532	35
ESI downgradient monitoring wells				
MW-8	515	505	519	14
MW-9	dry	495	511	16
MW-10	506	499	512	13
IB-4	513	482	524	42
IB-5	493	472	502	30
IB-9	502	490	505	15
IB-10	507	487	518	31
IB-11	509	489	518	29
IB-1	487	454	518	64
IB-8	265	155	461	306
IB-13	265	175	328	153
WSI monitoring wells (gradients have not been established)				
MW-2B	408	388	500	112
MW-3B	383	362	420	58
MW-4B	414	398	420	22
MW-5B	376	340	450	110
MW-6B	435	400	450	50
MW-7B	379	360	470	110
Aluminum Plant Drinking Water				
Well-1	252	-648	480	1,128
Well-2	230	-500	500	1,000
Well-3	222	-39	465	504
Well-4	434	325	450	125
Corps of Engineers Wells				
Well-1	126	-522	247	769
Well-2	**	-208	250	458
Well-3	146	-543	236	779

* All readings are given in feet above mean sea level unless otherwise indicated.

** Artesian well

TABLE 2

SIGNIFICANT FINDINGS OF EPA PRIORITY POLLUTANT
ANALYSIS OF ESI INFLUENT

COMMONWEALTH ALUMINUM
EAST SURFACE IMPOUNDMENT

GWQAP 1985 PLAN IMPLEMENTATION

	SAMPLE 1 (SS#10816)	SAMPLE 2 (SS#10826)	AVERAGE
VOLATILE ORGANICS			
1. Methylene Chloride	15 ug/l	<10 ug/l	<12.5 ug/l
ACID EXTRACTABLE ORGANICS			
2. Phenol	480 ug/l	680 ug/l	580 ug/l
BASE-NEUTRAL EXTR. ORGANICS	(UG/L)	(UG/L)	(UG/L)
3. Napthalene	12	<10	<11
4. Phenanthrene	30	18	24
5. Anthracene	15	13	14
6. Fluoranthene	32	25	28.5
7. Pyrene	27	21	24
8. Benzo(a)Anthracene	59	12	35.5
9. Chrysene	66	27	46.5
10. Benzo(a)Fluoranthene	38	16	27
11. Benzo(a)Pyrene	17	<10	<13.5
INORGANICS	(MG/L)	(MG/L)	(MG/L)
12. Arsenic	0.22	0.31	0.26
13. Beryllium	0.02	<0.02	<0.02
14. Cadmium	0.04	0.31	0.18
15. Chromium	0.15	0.07	0.11
16. Copper	0.18	0.10	0.14
17. Lead	3.20	0.95	2.08
18. Mercury	0.15	0.01	0.08
19. Nickel	13.0	5.70	9.40
20. Selenium	0.02	<0.01	<0.02
21. Thallium	0.16	0.16	0.16
22. Zinc	0.63	0.31	0.47
23. Cyanide	2.10	2.40	2.20
24. Phenols	1.00	1.00	1.00

TABLE 3

FINDINGS OF CHEMICAL ANALYSIS OF WSI SLUDGE

WSI CLOSURE AND POST-CLOSURE PLANS

Commonwealth Aluminum

COMPOUND	CONCENTRATION (PPM) Composite Sample	Individual Sample
Pesticides/PCB's	all bdl	all bdl
Semi-Volatiles		
Phenanthrene	140	230
Fluoranthene	1100	3000
Pyrene	900	2600
Benzo(a)anthracene	220	2590
Chrysene	310	810
Benzo(b)fluoranthene	340	710
Benzo(k)fluoranthene	---	710
Benzo(a)pyrene	110	240
Inorganics		
Arsenic	28	47
Cadmium	5	6
Chromium, total	9	10
Copper	11	9
Lead	91	97
Nickel	380	310
Zinc	29	49
Calcium	2.5	4.4
Chloride	1794	2211
Total Cyanide	1.3	5.1
Fluoride	51600	26900
Iron	2700	1960
Magnesium	2.4	3.7
Manganese	30	18
Potassium	28	46
Aluminum	9%	10%
Lithium	3.2	3.4
Sodium	9220	11960
Sulphate	3900	4923
Vanadium	146	116
Titanium	62	204
Total Carbon	12.8%	15.4%
Cyanide, total	bdl	bdl
Phenols, total	2	3
Volatile Organics	all bdl	all bdl
RCRA/SDWA Herbicides	all bdl	all bdl
RCRA/SDWA Pesticides	all bdl	all bdl
RCRA/SDWA Metals (EP Toxicity)		
Arsenic	0.05	0.07
Cadmium	0.02	0.01
Nickel	0.65	1.10
Zinc	0.13	0.30
Iron	6.20	5.80
Manganese	1.10	0.11
Corrosivity	bdl	bdl
Ignitability (C)	7110	7110
Reactivity	N.C.	N.C.

NOTES: bdl = below detection limit
N.C. = not characteristic

TABLE 4

ESI SLUDGE ANALYTICAL RESULTS

COMMONWEALTH ALUMINUM
EAST SURFACE IMPOUNDMENT

GWQAP 1985 PLAN IMPLEMENTATION

INORGANICS	INDIVIDUAL SAMPLE	COMPOSITE SAMPLE
FLUORIDE	3100	4400
CHLORIDE	150	400
SULFATE	16000	15000
NITRATE	70	90
SILICA	960	1000
TOTAL CYANIDE	0.27	0.61
CALCIUM	190000	160000
IRON	2500	2200
MAGNESIUM	1100	810
MANGANESE	28	17
POTASSIUM	330	260
SODIUM	180	220
VANADIUM	310	320
ALUMINUM	10000	13000
COPPER	19	15
NICKEL	400	375
ARSENIC	3.5	4.2
CHROMIUM	5.6	5.3
LEAD	120	63
ZINC	25	17
CADMIUM	4.5	3.9
SILVER	1.0	1.0
THALLIUM	6.2	3.1
STRONTIUM	33	47
ORGANICS		
TOTAL ORGANIC CARBON	54	140
PHENANTHRENE	700	32
FLUORANTHENE	1500	190
PYRENE	1400	210
BENZO(A)ANTHRACENE	510	85
CHRYSENE	1100	180
BENZO(B)FLUORANTHENE	1500(1)	210(1)
BENZO(K)FLUORANTHENE	1500(1)	210(1)
BENZO(A)PYRENE	450	66
INDENO(1,2,3-C,D)PYRENE	240	34
BENZO(G,H,I)PERYLENE	310	43
PHENOLS	0.68	L/.1

Concentrations reported in (mg/kg)
(1) Indistinguishable Isomers

TABLE 5

METHOD REFERENCES FOR CHEMICAL ANALYSIS

COMMONWEALTH ALUMINUM
EAST SURFACE IMPOUNDMENT

GWQAP 1985 PLAN IMPLEMENTATION

PARAMETER	METHOD REFERENCE
Metals (Sludge)	EPA 600-4-79-020
Metals (Water)	Standard Methods 303A
Cyanides (Sludge)	SW 846 Method 9010
Cyanides (Water)	EPA 600-4-78-020 335.3
Fluoride (Sludge)	EPA 600-4-79-020 340.2
Fluoride (Water)	Standard Methods 413.3
Chloride	EPA 600-4-79-020 325.3
Sulfate	Standard Methods 426C
Total Organic Carbon (Sludge)	SW 846 Method 9060
Total Organic Carbon (Water)	
Silica	Standard Methods 425A
Phenols	EPA 600-4-79-020 420.2
Semi-Volatiles	EPA Method 625 Vol.49, 10/26/84FR
Volatiles	EPA Method 624 Vol.49, 10/26/84FR
Pesticides/PCBs	EPA Method 608 Vol.49, 10/26/84FR
Nitrates	
Total Organic Halogen	
pH	EPA 600-4-78-020 150.1
Specific Conductance	EPA 600-4-78-020 120.1

TABLE 6

GROUND WATER MONITORING
QUARTERLY 40 CFR 265 SUBPART F
ANALYTICAL RESULTS

1984

LOCATION	GOLDENDALE, EAST POND AREA				
WELL	1	8	9	10	
DATE	6/28	6/28	7/02	7/02	
STATIC WATER LEVEL (FEET)	529.21	513.05	504.83	507.22	
pH	7.30	7.00	7.30	7.60	
CONDUCTIVITY (UMHOS/CM)	293.00	1055.00	19000.0	1200.00	
TOC (MG/L)	1.80	2.30	23.00	5.00	
TOX (UG/L)	30.00	45.00	70.00	45.00	
CHLORIDE (MG/L)	2.00	36.00	3.00	22.00	
IRON (MG/L)	.30	.33	.78	.50	
MANGANESE (MG/L)	.09	.01	94.00	.04	
PHENOLS (UG/L)	L/5	L/5	L/5	L/5	
SODIUM (MG/L)	33.00	80.00	7000.00	230.00	
SULFATE (MG/L)	40.00	61.00	685.00	380.00	
ARSENIC (UG/L)	L/5	L/5	L/5	8.00	
BARIUM (UG/L)	L/20	L/20	L/20	L/20	
CADMIUM (UG/L)	L/1	L/1	L/1	L/1	
CHROMIUM (UG/L)	L/2	L/2	L/2	L/2	
FLUORIDE (MG/L)	.30	1.50	25.00	8.30	
LEAD (UG/L)	L/2	L/2	.05 52.00	L/2	
MERCURY (UG/L)	L/1	L/1	L/1	L/1	
NITRATE as N (UG/L)	330.00	2700.00	360.00	2400.00	
SELENIUM (UG/L)	L/5	L/5	L/5	L/5	
SILVER (UG/L)	L/1	L/1	1.00	L/1	
ENDRIN (UG/L)	L/.05	L/.05	L/1	L/.05	
LINDANE (UG/L)	L/.05	L/.05	L/1	L/.05	
METHOXYCHLOR (UG/L)	L/.1	L/.1	L/.2	.60	
TOXAPHENE (UG/L)	L/1	L/1	L/2	L/1	
2,4-D (UG/L)	L/.2	L/.2	L/.2	L/.2	
2,4,5-TP SILVEX (UG/L)	L/.1	L/.1	L/.1	L/.1	
RADIUM	L/1	L/1	L/1	L/1	
GROSS ALPHA	L/2	L/2	L/2	L/2	
GROSS BETA	3.00	10.00	15.00	3.00	
TURBIDITY (NEPH.UNITS)	41.00	1.40	.31	.60	
COLIFORM BACTERIA	G/16		L/2.2		
FREE CYANIDE (UG/L)					
TOTAL CYANIDE (UG/L)	L/5	L/5	18.00	5.00	
COLOR (UNITS)	10.00	10.00	250.00	20.00	
HARDNESS (MG/L)	97.00	275.00	2630.00	250.00	
BENZO(a)PYRENE (UG/L)	L/.05	L/.05	.12	L/.05	

GWQAP GROUND WATER ANALYTICAL RESULTS

TABLE 7

COMMONWEALTH ALUMINUM
EAST SURFACE IMPOUNDMENT

GWQAP 1985 PLAN IMPLEMENTATION

NOVEMBER 11,1985

PARAMETERS / WELL No's.	MW-1	MW-8	MW-10	IB-1	* IB-2	IB-2A	IB-3	IB-4	IB-5	IB-5A	IB-5AA	* IB-8	IB-9	IB-10	IB-11	IB-12A	* IB-13	* IB-13A
INORGANICS:																		
COPPER	L/20	L/20	200	L/20	*	L/20	L/20	L/20	20	L/20	L/20	*	240	L/20	L/20	70	*	*
MERCURY	1.9	0.9	0.9	1.0	*	0.9	0.9	0.2	0.9	0.2	L/0.2	*	0.9	0.5	L/0.2	L/0.2	*	*
NICKEL	L/40	L/40	210	L/40	*	L/40	L/40	L/40	90	L/40	L/40	*	90	L/40	L/40	150	*	*
SILVER	L/10	L/10	20	L/10	*	L/10	L/10	L/10	10	L/10	L/10	*	30	L/10	L/10	10	*	*
THALLIUM	L/100	L/100	L/100	L/100	*	L/100	L/100	L/100	L/100	L/100	L/100	*	L/100	L/100	L/100	100	*	*
ZINC	L/10	L/10	L/10	L/10	*	L/10	L/10	20	L/10	20	L/10	*	L/10	L/10	L/10	10	*	*
CHLORIDE	6700	8700	459000	39000	*	7400	1400	1100	36000	13000	281000	*	258000	8700	24000	140000	*	*
IRON	L/10	2300	68000	150	*	40	140	160	1200	13000	130	*	4800	3900	1600	2700	*	*
MANGANESE	40	20	2900	90	*	L/5	730	110	900	310	130	*	140	20	100	2700	*	*
SODIUM	5600	25000	2780000	184000	36000	47000	7100	2400	204000	27000	593000	77000	3063000	18000	52000	976000	36000	51000
SULFATE	39000	46000	13000000	3300000	130000	89000	71700C	109000	1750000	772000	3500000	710000	15500000	172000	970000	7100000	360000	625000
FLUORIDE	150	2100	12800	240	1600	19400	240	380	370	240	350	1000	6500	260	710	2300	2400	2400
NITRATE	1200	1700	1700	3200	*	800	1900	1100	870	560	760	*	1200	1000	720	400	*	*
TURBIDITY (NEPH.UNITS)	2.5	0.60	25	1.5	*	0.30	55	3.0	3.5	60	2.6	*	35	8.5	1.3	60	*	*
TOTAL CYANIDE	L/5	L/5	13	L/5	L/5	L/5	L/5	L/5	L/5	L/5	L/5	230	11	L/5	L/5	L/5	L/5	L/5
HARDNESS	68000	104000	2084000	2999000	*	97000	86000	203000	2913000	316000	2679000	*	3410000	248000	225000	3190000	*	*
POTASSIUM	5000		36000															
CALCIUM	9000		140000															
STRONTIUM	1000		53000															
STATIC WATER LEVEL MSL	527.96	511.60	504.28	404.23	468.80	508.80	521.33	512.48	491.99	425.37	443.52	265.29	499.80	507.20	506.75	496.96	263.91	263.88
pH	7.49	7.43	7.15	7.26	8.43	7.97	7.60	7.41	7.89	7.72	8.19	7.86	7.63	7.64	7.90	7.89	8.14	7.91
CONDUCTIVITY (UMHOS/CM)	199	382	17525	4215	561	487	230	451	4500	1290	6378	1350	20250	618	637	8220	1055	1090
ORGANICS																		
METHYLENE CHLORIDE	1.0	L/5	5.0	13	*	L/5	L/5	L/5	L/5	L/5	L/5	*	18	13	L/5	L/5	*	*
TRICHLOROFLUOROMETHANE	11	L/5	L/5	5.0	*	L/5	L/5	L/5	L/5	L/5	L/5	*	L/5	5.0	L/5	L/5	*	*
TOTAL PHENOLICS	----	L/2	----	L/2	*	L/2	L/2	7	4	2	7	*	3	3	3	I.S.	*	*
TOC	5200	L/200	19900	6300	*	200	300	1230	6900	900	7400	*	21600	4100	2000	17600	*	*
TOX	70.2	12.1	114.0	61.7	*	4.6	26.0	26.1	40.8	14.9	70.5	*	151.6	5.0	6.4	93.7	*	*
Bis(2-ethylhexyl)phathate			39.00															

Results are reported in micrograms per liter.

* Wells analyzed for monthly parameters only.

Analysis for monitory wells 1 and 10 are based on Appendix VIII parameters.

pH, Conductivity, TOC, TOX, are an average of four test results.

I.S. Insufficant sample

MW-9, IB-6 and IB-7 Dry.

TABLE 8

Groundwater Sample Data for Fluoride (mg/l)

Well #	Static Water Elevation *	Well Bottom Elevation *	Data and Collection Intervals					
ESI upgradient monitoring wells			1985	1986	10/87	1/88	4/88	7/88
MW-1	530	508	0.15	0.18	0.19	***	0.16	0.19
IB-3	524	497	0.24	0.26	0.23		0.20	0.25
ESI downgradient monitoring wells								
MW-8	515	505	2.10	1.40	3.78		1.70	1.50
MW-9	dry	495	dry	---	---		---	---
MW-10	506	499	12.8	15.3	15.1		13.5	14.0
IB-4	513	482	0.38	0.34	0.53		0.26	0.33
IB-5	493	472	0.37	0.26	****		0.26	0.23
IB-9	502	490	6.50	6.70	5.15		4.40	4.50
IB-10	507	487	0.26	0.38	0.30		0.26	0.27
IB-11	509	489	0.71	1.10	0.80		0.78	0.66
IB-1	487	454	0.24	0.27	0.24		0.22	0.21
IB-8	265	155	****	0.65	****		0.22	1.00
IB-13	229	175	2.40	2.65	2.37		2.60	3.50
Blank			****	.025	<.05		<.02	****
WSI monitoring wells**				10/86	1/87	7/87		
MW-2B	408	388		0.33	0.33	0.36		
MW-3B	383	362		0.28	0.24	0.24		
MW-4B	414	398		0.25	0.23	0.21		
MW-5B	376	340		0.26	0.23	0.23		
MW-6B	435	400		0.18	****	****		
MW-7B	379	360		0.46	0.37	0.42		
Blank				0.02	****	****		
Aluminum Plant Drinking Water					5/87			
Well-1	252	-648			0.54			

* All readings are given in feet above mean sea level unless otherwise indicated.
** There is some uncertainty relating to groundwater gradients near the WSI, therefore gradient indications for the WSI data will be omitted.
*** Fluoride was not analyzed during this period.
**** Data was missing or the sample was too small.

TABLE 9

Groundwater Sample Data for Sulfate (mg/l)

Well #	Static Water Elevation *	Well Bottom Elevation *	Data and collection intervals					
ESI upgradient monitoring wells			1985	1986	10/87	1/88	4/88	7/88
MW-1	530	508	39	18	14	16	18	15
IB-3	524	497	717	20	18	19	21	21
ESI downgradient monitoring wells								
MW-8	515	505	46	38	54	130	104	80
MW-9	dry	495	dry	---	---	---	---	---
MW-10	506	499	13000	5000	4538	2840	2335	3740
IB-4	513	482	109	80	103	157	139	100
IB-5	493	472	1750	2360	****	2780	2550	3060
IB-9	502	490	15500	12000	10240	10060	8200	11700
IB-10	507	487	172	300	252	250	242	315
IB-11	509	489	970	62	72	73	154	188
IB-1	487	454	3300	2060	2795	1750	****	2800
IB-8	265	155	710	725	****	673	660	1180
IB-13	229	175	360	350	362	364	320	464
Blank			****	<1	<0.1	<0.5	<3	****
WSI monitoring wells**				10/86	1/87	7/87		
MW-2B	408	388		19	16	15		
MW-3B	383	362		17	27	26		
MW-4B	414	398		13	15	14		
MW-5B	376	340		7.5	11	11		
MW-6B	435	400		9.5	****	****		
MW-7B	379	360		63	67	74		
Blank				<1	****	****		
Aluminum Plant Drinking Water					5/87			
Well-1	252	-648			53			

* All readings are given in feet above mean sea level unless otherwise indicated.

** There is some uncertainty relating to groundwater gradients near the WSI, therefore gradient indications for the WSI data will be omitted.

**** Data was missing or the sample was too small.

TABLE 10

Groundwater Sample Data for Total Cyanide (ug/l)

Well #	Static Water Elevation *	Well Bottom Elevation *	Data and collection intervals					
ESI upgradient monitoring wells			1985	1986	10/87	1/88	4/88	7/88
MW-1	530	508	<5	<5	<5	<5	***	<5
IB-3	524	497	<5	<5	<5	<5		<5
ESI downgradient monitoring wells								
MW-8	515	505	<5	<5	6	14		****
MW-9	dry	495	dry	---	---	---		---
MW-10	506	499	13	6	<5	12		15
IB-4	513	482	<5	<5	<5	<5		<5
IB-5	493	472	<5	<5	****	<5		<5
IB-9	502	490	11	7	<5	10		<5
IB-10	507	487	<5	<5	<5	<5		<5
IB-11	509	489	<5	<5	<5	<5		<5
IB-1	487	454	<5	13	13	11		<5
IB-8	265	155	230	303	****	278		109
IB-13	229	175	<5	<5	<5	<5		<5
Blank			****	<5	<5	<5		****
WSI monitoring wells**				10/86	1/87	7/87		
MW-2B	408	388		<5	<5	<5		
MW-3B	383	362		<5	<5	<5		
MW-4B	414	398		<5	<5	<5		
MW-5B	376	340		<5	<5	<5		
MW-6B	435	400		14	****	****		
MW-7B	379	360		<5	<5	<5		
Blank				<5	****	****		
Aluminum Plant Drinking Water					5/87			
Well-1	252	-648			<5			

* All readings are given in feet above mean sea level unless otherwise indicated.
** There is some uncertainty relating to groundwater gradients near the WSI, therefore gradient indications for the WSI data will be omitted.
*** Cyanide was not analyzed during this period.
**** Data was missing or the sample was too small.

TABLE 11

Groundwater Sample Data for Total Organic Halogens (TOX) (ug/l)
(all data rounded to the nearest whole number)

Well #	Static Water Elevation *	Well Bottom Elevation *	Data and collection intervals					
ESI upgradient monitoring wells			1985	1986	10/87	1/88	4/88	7/88
MW-1	530	508	70	11	<10	13	<10	<10
IB-3	524	497	26	4	<10	<10	<10	****
ESI downgradient monitoring wells								
MW-8	515	505	12	10	15	24	18	12
MW-9	dry	495	dry	---	---	---	---	---
MW-10	506	499	114	197	57	69	****	55
IB-4	513	482	26	23	<10	12	<10	<10
IB-5	493	472	49	34	****	21	****	20
IB-9	502	490	151	114	88	85	109	110
IB-10	507	487	5	20	16	16	17	13
IB-11	509	489	6	47	<10	11	<10	<10
IB-1	487	454	62	56	58	44	45	60
IB-8	265	155	BDL	38	****	15	15	18
IB-13	229	175	BDL	18	<10	<10	<10	<10
Blank			****	4.5	<10	45	<10	<10
WSI monitoring wells**				10/86	1/87	7/87		
MW-2B	408	388		***	***	***		
MW-3B	383	362						
MW-4B	414	398						
MW-5B	376	340						
MW-6B	435	400						
MW-7B	379	360						
Blank								
Aluminum Plant Drinking Water					5/87			
Well-1	252	-648			***			

* All readings are given in feet above mean sea level unless otherwise indicated.
** There is some uncertainty relating to groundwater gradients near the WSI, therefore gradient indications for the WSI data will be omitted.
*** TOX was not analyzed during this period.
**** Data was missing or the sample was too small.
BDL Below detectable limits

TABLE 12

Groundwater Sample Data for Total Organic Carbon (TOC) (mg/l)
(all data rounded to the nearest tenth)

Well #	Static Water Elevation *	Well Bottom Elevation *	Data and collection intervals					
ESI upgradient monitoring wells			1985	1986	10/87	1/88	4/88	7/88
MW-1	530	508	5.2	1.7	13.4	12.4	5.6	3.7
IB-3	524	497	0.3	0.8	7.7	7.9	5.8	3.6
ESI downgradient monitoring wells								
MW-8	515	505	<0.2	1.3	13.1	22.0	9.8	6.2
MW-9	dry	495	dry	---	---	---	---	---
MW-10	506	499	19.9	13.6	41.3	37.0	30.2	36.1
IB-4	513	482	1.2	0.9	10.7	2.2	7.2	4.3
IB-5	493	472	6.9	6.3	****	12.6	13.6	79.2
IB-9	502	490	21.6	19.2	41.2	54.1	66.2	51.2
IB-10	507	487	4.1	4.6	8.0	10.9	15.0	11.1
IB-11	509	489	2.0	2.8	13.1	15.1	30.5	18.9
IB-1	487	454	6.3	4.5	13.4	18.2	****	22.4
IB-8	265	155	****	1.5	****	8.3	10.0	5.0
IB-13	229	175	****	1.1	4.0	7.2	7.1	4.7
Blank			****	<0.2	1.4	1.5	1.0	****
WSI monitoring wells**				10/86	1/87	7/87		
MW-2B	408	388		***	<0.6	1.4		
MW-3B	383	362			<0.6	1.1		
MW-4B	414	398			<0.6	0.5		
MW-5B	376	340			<0.6	0.5		
MW-6B	435	400			****	****		
MW-7B	379	360			<0.6	0.4		
Blank								
Aluminum Plant Drinking Water					5/87			
Well-1	252	-648			<0.6			

* All readings are given in feet above mean sea level unless otherwise indicated.
** There is some uncertainty relating to groundwater gradients near the WSI, therefore gradient indications for the WSI data will be omitted.
*** TOC was not analyzed during this period.
**** Data was missing or the sample was too small.

TABLE 13

Groundwater Sample Data for Total Phenols (ug/l)

Well #	Static Water Elevation *	Well Bottom Elevation *	Data and collection intervals					
ESI upgradient monitoring wells			1985	1986	10/87	1/88	4/88	7/88
MW-1	530	508	****	***	***	<5	***	***
IB-3	524	497	<2			****		
ESI downgradient monitoring wells								
MW-8	515	505	<2			<5		
MW-9	dry	495	****			****		
MW-10	506	499	****			<5		
IB-4	513	482	7			<5		
IB-5	493	472	4			<5		
IB-9	502	490	3			<5		
IB-10	507	487	3			5		
IB-11	509	489	3			<5		
IB-1	487	454	<2			<5		
IB-8	265	155	****			<5		
IB-13	229	175	****			7		
Blank			****			<5		
WSI monitoring wells**				10/86	1/87	7/87		
MW-2B	408	388		***	***	***		
MW-3B	383	362						
MW-4B	414	398						
MW-5B	376	340						
MW-6B	435	400						
MW-7B	379	360						
Blank								
Aluminum Plant Drinking Water					5/87			
Well-1	252	-648			***			

* All readings are given in feet above mean sea level unless otherwise indicated.

** There is some uncertainty relating to groundwater gradients near the WSI therefore gradient indications for the WSI data will be omitted.

*** Phenol was not analyzed during this period.

**** Data was missing or the sample was too small.

TABLE 14

NATIONAL PRIORITY DRINKING WATER REGULATIONS

MAXIMUM CONTAMINANT LEVELS (MCLs) (mg/l)*

Primary Standards

Arsenic	0.05
Barium	1.0
Cadmium	0.01
Chromium (Cr^{6+})	0.05
Lead	0.05
Mercury	0.002
Nitrate (as N)	10.0
Selenium	0.01
Silver	0.05
Antimony	0.01

Chlorinated Hydrocarbons

Endrin	0.0002
Lindane	0.004
Methoxychlor	0.1
Toxaphene	0.005

Chlorophenoxys

2,4-D	0.1
2,4,5-TP Silvex	0.01

Miscellaneous

Phenols	0.001
Carbon Chloroform Extract	0.2
Synthetic Detergents –	0.5
Cyanide	0.20

PROPOSED MAXIMUM CONTAMINANT LEVELS (MCLs) (mg/l)**

Vinyl Chloride	0.001
Benzene	0.005
Carbon Tetrachloride	0.005
1,2-dichloroethane	0.005
Trichloroethylene	0.005
1,1-dichloroethylene	0.007
1,1,1-trichloroethane	0.2
p-dichlorobenzene	0.75

PROPOSED RECOMMENDED MAXIMUM CONTAMINANT LEVELS (RMCLs)** FOR CHEMICAL AND MICROBIOLOGICAL PARAMETERS (mg/l)

Inorganic Chemicals

Arsenic	0.05
Asbestos	7.1×10^6 long fibers/L
Barium	1.5
Cadmium	0.005
Chromium (Total)	0.12
Copper	1.3
Lead	0.02
Mercury	0.003
Nitrate	10.0
Nitrite	1.0
Selenium	0.045
Fluoride	4.0

Synthetic Organic Chemicals

Acrylamide	0
Alachlor	0
Aldicarb (including two by-products, aldicarb sulfoxide & aldicarb sulfone)	0.009
Carbofuran	0.036
Chlordane	0
cis-1,2-Dichloroethylene	0.07
Dibromochloropropane (DBCP)	0
1,2-Dichloropropane	0.006
o-Dichlorobenzene	0.62
2,4-Dichlorophenoxyacetic acid (2,4-D)	0.07
Epichlorohydrin	0
Ethylbenzene	0.68
Ethylenedibromide (EDB)	0
Heptachlor	0
Heptachlor epoxide	0
Lindane	0.0002
Methoxychlor	0.34
Monochlorobenzene	0.06
Pentachlorophenol	0.22
Polychlorinated Biphenyls (PCBs)	0
Styrene	0.14
Toluene	2.0
Toxaphene	0
trans-1,2-Dichloroethylene	0.07
2-(2,4,5-Trichlorophenoxy) propianic acid (2,4,5-TP)	0.052
Xylene	0.44

Microbiological Parameters

Giardia	0 organisms
Total coliforms	0 organisms
Turbidity	0.1 nephelometric turbidity unit
Viruses	0 organisms

SECONDARY STANDARDS*

Boron	1.0 mg/l	Odor	3 threshold odor No.
Chloride (Cl)	250 mg/l	pH	6.5 to 8.5
Color	15 color units	Sulfate (SO_4^{2-})	250 mg/l
Copper	1 mg/l	TDS	500 mg/l
Foaming Agents	0.5 mg/l	Zinc	5 mg/l
Iron	0.3 mg/l		
Manganese	0.05 mg/l		
Nitrate (NO_3^-)	45 mg/l		

* EPA, 1975

** EPA, Federal Register, 11/13/85

TABLE 15

COMPARATIVE ANALYTICAL RESULTS OF WASTEWATER SAMPLES COLLECTED AT
Columbia Aluminum, Goldendale, Washington
November 18, 1987

DISCHARGE DISCRIPTION	PARAMETERS in mg/L unless specified	LABORATORY WDOE	LABORATORY INDUSTRY	INSPECTION RESULTS	PERMIT LIMITATIONS lbs/day unless specified
West Surface Impoundment (WSI)-Grab	pH (units)	6.9	6.7		N/A
	Conductance @ 25	46400			umhos/cm @ 25 degrees C
	Total Fluoride	1700	1560		N/A
	Total Sulfate	33000			N/A
001 River Discharge-Grab	pH (units)	7.7	7.9	7.7	7.0 to 9.0
	TSS	5			N/A
	Oil & Grease	5	1	243	500 lbs/day maximum
	B(a)P	< .0002		< .0097	0.2 lbs/day maximum
	Total Fluoride	5.6	5.84		N/A
	Nickel	< .005	.006		N/A
	Aluminum	.115	.19		N/A
	Antimony	< .001	< .005		N/A
	Temperature F	61		61	Degrees F
	Flow MGD	8	5.83	5.83	MGD
001 River Discharge-Composite	pH (units)	7.8	7.9	7.8	7.0 to 9.0
	TSS	1	0	49	1500 lbs/day maximum
	Total Fluoride	6	4.21	292	485 lbs/day maximum
	Nickel	< .005		< .243	3.6 lbs/day maximum
	Aluminum	.101		4.9	90 lbs/day maximum
	Antimony	.003		.15	12.6 lbs/day maximum
	Temperature F	61		61	Degrees F
	Flow MGD		5.83	5.83	MGD
Sanitary-Grab	pH (units)	7	.72	7	7.0 to 9.0
	BOD/5	5		5	45 mg/l maximum
	Fecal Coliform (col./100mls.)	< 1		< 1	400 colonies/100mls
	TSS	5	8	5	45 mg/l
	Residual Chlorine	1.5		1.5	5.0 mg/l maximum
	Flow MGD		.02279	.02279	MGD
Roof Scrubbers-Grab	TSS	1	1	.9	100 lbs/day maximum
	Total Fluoride	10	10	9.2	50 lbs/day maximum
	Flow MGD		.11	.11	MGD
Influent to WSI-Grab	Total Fluoride	800	874		N/A

TABLE 16

COMPARATIVE ANALYTICAL RESULTS OF WASTEWATER SAMPLES COLLECTED AT
Commonwealth Aluminum, Goldendale, Washington
May 21, 1987

DISCHARGE DISCRIPTION	PARAMETERS in mg/L unless specified	LABORATORY WDOE	LABORATORY INDUSTRY	INSPECTION RESULTS	PERMIT LIMITATIONS lbs/day unless specified
001-Grab	Total Fluoride	15	14.6	0	485 lbs/day maximum
	Flow MGD		0	0	MGD
East Rivulet-Grab	Total Fluoride	6.5	6.32		N/A
West Rivulet-Grab	Total Fluoride	4.2	4.15		N/A
Boat Basin-Grab	Total Fluoride	.17	.21		N/A
WMA Spring-Grab	Total Fluoride	.18	.33		N/A
Storm Basin-Grab	Total Fluoride	2.9	3.05		N/A
Inlet to Pond A-Grab	Total Fluoride	4.7	4.82		N/A

TABLE 17

Commonwealth Aluminum Discharge Characteristics
(Yearly Averages)

Year (Plant start up 11/71)	Flouride Concentration (mg/L)	Effluent Flow (mgd)	Fluoride Discharge (lbs./day)
1972	34.8	19.4	5630
73	30.1	19.0	4770
74	28.7	19.8	4740
75	27.0	18.3	4117
76	25.3	19.0	3994
77	20.8	18.9	3279
78	25.3	18.1	3750
79	15.6	16.1	2088
80	10.2	7.7*	626
81	14.4	5.6	651
82	11.0	9.5	874**
83	6.4	9.5	655***
84	4.0	8.5	284
85 (to date)	1.8	8.4	127

*In February 1980, Martin Marietta began recycling a substantial portion of the air pollution scrubber water, resulting in a significant drop in effluent volume discharged to the river.

**Start up problems associated with expansion.

***Accidental discharge of excess fluorides and solids in September/ October - disregarding accident, average would have been about 280 lbs./day.

TABLE 18

sums of concentrations of selected 1- through 5-ring aromatic compounds
ediment samples from Columbia River and Puget Sound (ng/g dry weight).

	Columbia R. stations			Puget Sound sites		
	2	4	10[a]	Duwamish Waterway[b]	Hylebos Waterway[c]	Port Madison[d]
trations 5 ring unds e 3.	250	86	8,300 [range 1,300–16,000]	11,000 [range 4,100–22,000]	18,000 [range 5,000 39,000]	480 [range 200–640]
trations 5-ring ed in	240	82	8,000 [range 2,600–16,000]	10,000 [range 3,700–20,000]	13,000 [range 3,800–33,000]	340 [range 160–510]

r four samples (Damkaer 1983).

aterway, Seattle, WA, average for four samples (Malins et al. 1980, 1982).

terway, Tacoma, WA, average for six samples (Malins et al. 1980, 1982).

on, Puget Sound, WA, average for two samples (Malins et al. 1980, 1982).

TABLE 19

Concentrations of aromatic compounds in sediment and water collected from the John Day Dam region, Columbia River.

Settling pond water (ng/ml) 6/11/82	Sediment (ng/g, dry weight)							
	Station 2 4/24/82	Station 4 4/24/82	Station 10 4/24/82-1	Station 10 4/24/82-2	Station 10+ 6/11/82	Station 10 6/11/82	L1 6/11/82	L2 6/11/82
<.08	<.83	<.83	<.83	<.83	<.5	3.0	13	<1.0
<.09	<.92	<.92	<.92	<.92	<.5	1.5	<1.1	<1.0
<.09	<.87	<.87	<.87	<.87	<.5	1.2	3.7	1.4
<.08	<.83	<.83	<.83	<.83	<.5	<.5	<1.0	<1.0
<.07	<.76	<.76	13	12	<.5	<.5	42	29
<.10	<1.1	<1.1	<1.1	<1.1	4.0	10	3.4	4.7
<.08	<.85	<.85	5.7	6.1	18	13	20	9.7
<.07	<.40	<.70	2.9	3.2	6.6	11	19	33
<.08	<.80	<.80	<.80	<.80	<.5	<.5	.8	6.3
<.08	<.82	<.82	<.82	<.82	<.5	0.8	2.9	<.7
<.07	<.73	<.73	16	13	8.0	5.6	110	55
<.08	<.72	3.4	<.72	<.72	<.5	4.4	<.7	<.7
<.07	<.82	<.82	23	20	13	8.2	78	44
<.08	<.80	<.80	10	10	1.1	<.5	39	22
<12	16	14	230	230	100	66	830	460
<.07	<.85	<.85	140	140	37	16	200	88
0.64	<.5	<.84	30	30	27	22	59	43
0.25	<2.3	<2.3	25	25	11	11	53	26
0.69	49	13	1100	1200	340	140	2000	1400
0.51	49	14	1100	1200	360	150	2300	1500
0.52	20	4.3	1500	2000	280	100	1200	720
1.5	39	12	4000	5800	780	310	2100	1500
0.93	23	6.9	1800	2400	330	180	1300	770
0.37	19	4.7	1700	2100	270	150	1200	720
<0.07	28	13	400	460	83	78	320	180
0.10	7.4	<1.9	630	700	140	94	430	280

TABLE 20

Target organic compounds analyzed in water and sediment samples from the John Day Dam region, Columbia River. Detection limits for 800-ml water samples are noted in ppb after the compound.

Aromatic hydrocarbons (AHs):

1.	Isopropylbenzene	0.08
2.	*n*-Propylbenzene	0.09
3.	Indan	0.09
4.	1,2,3,4-Tetramethylbenzene	0.08
5.	Naphthalene	0.07
6.	Benzothiophene	0.10
7.	2-Methylnaphthalene	0.08
8.	1-Methylnaphthalene	0.07
9.	Biphenyl	0.08
10.	2,6-Dimethylnaphthalene	0.08
11.	Acenaphthene	0.07
12.	2,3,5-Trimethylnaphthalene	0.08
13.	Fluorene	0.08
14.	Dibenzothiophene	0.08
15.	Phenanthrene	0.07
16.	Anthracene	0.07
17.	1-Methylphenanthrene	0.08
18.	3,6-Dimethylphenanthrene	0.21
19.	Fluoranthene	0.08
20.	Pyrene	0.10
21.	Benz[a]anthracene	0.08
22.	Chrysene	0.10
23.	Benzo[e]pyrene	0.09
24.	Benzo[a]pyrene	0.08
25.	Perylene	0.07
26.	Dibenzanthracene	0.16
27.	Benzofluoranthene	

Chlorinated pesticides:

Hexachlorobenzene (HCB)	0.002
Lindane (γ - BHC)	0.002
Heptachlor	0.002
Aldrin	0.002
o,p'-DDE	0.004
α-Chlordane	0.002
trans-Nonachlor	0.002
p,p'-DDE	0.002
o,p'-DDD	0.004
m,p'-DDD	0.004
p,p'-DDD	0.003
o,p'-DDT	0.003
p,p'-DDT	0.003
Dichlorobiphenyls)	
Trichlorobiphenyls)	
Tetrachlorobiphenyls)	
Pentachlorobiphenyls)	PCBs 0.017
Hexachlorobiphenyls)	
Heptachlorobiphenyls)	
Octachlorobiphenyls)	
Nonachlorobiphenyls)	
Dichlorobutadienes	
Trichlorobutadienes (3CBD))	
Tetrachlorobutadienes (TCBD))	CBDs .017
Pentachlorobutadienes (PCBD))	
Hexachlorobutadienes (HCBD))	
Ronnel[1/]	

TABLE 21

Concentrations of total and free copper, zinc, lead, and cadmium in the John Day Dam region, Columbia River, 1982.

	Total metal (ppb)		Free metal (ppb)		
water	Lagoon water	Outfall & lagoon sediments	Outfall area	North fishway	South fishway
)	<50	1000–2000	31	13.5	14.8
0 ver 10–17)	10	6000–8000	9	41.5	10.4
)	<10	1000	8.8	2.0	2.1
)	<0.5	100–200	1.3	0.7	1.4

TABLE 22

SUMMARY OF ANALYTICAL METHODS FOR WATER AND SEDIMENTS

PARAMETERS	MEDIA	METHOD
Metals (Total Recoverable)	Water	Method 4.1.4 Ref. EPA 600-4.79-972
Polynuclear Aromatic Hydrocarbons	Water	Method 610 Ref. EPA 600/4-82-057
Metals (Total)	Sediments	Mathod 3050 and appropriate 7000 series method Ref. EPA SW 846
Polynuclear Aromatic Hydrocarbons	Sediments	Method 3540 Method 8100 Ref. EPA SW 846

TABLE 23

WATER QUALITY CRITERIA AND DETECTION LIMITS

PARAMETERS	WATER QUALITY CRITERIA ug/l	DETECTION LIMITS
Cu	6.5	5
Zn	47	10
Cd	.66	0.4
Pb	1.3	1
Sb	None	20
Al	None	60
Ni	56	10
F	None	0.1
Napthalene	620.0	5
Fluorene	.031	5
Phenanthrene	.031	0.8
Anthracene	.031	0.5
Flouranthene	54	1.0
Pyrene	.031	0.5
Benz(a)anthracene	.031	0.5
Chrysene	.031	0.3
Benzo(g,h,i)perylene	.031	0.3
Benzo(a)pyrene	.031	0.3
Dibenz(a,h)anthracene	.031	1.0

TABLE 24

QUANTITY OF SEDIMENTS IN WASTEWATER LAGOONS

LAGOON	SEDIMENT VOLUME [cf]	WATER VOLUME [cf]
A	131,000	0
B	331,000	539,000
C	422,000	1,052,000
D	146,000	444,000

ORGANIC CONTENTS OF WASTEWATER LAGOON SEDIMENTS (úg/g)

PARAMETERS	LAGOONS			
	A	B	C	D
Napthalene	<780	290	<195	<775
Flourene	<100	110	<25	<100
Phenanthrene	1091	1340	1110	165
Anthracene	123	114	344	99
Fluoranthene	3441	4454	8800	3722
Pyrene	2556	3641	4923	2111
Benz(a)anthracene	1169	1406	1992	1424
Chrysene	1182	1684	2053	1483
Benzo(a)pryene	648	723	897	546
Dibenz(a,h)anthracene	293	262	<117	292
Benzo(g,h,i)perylene	459	478	349	318

METAL CONTENTS OF WASTEWATER LAGOON SEDIMENTS (úg/g)

SITE	AL	Sb	Cd	Cu	Pb	Ni	Zn
Lagoon A	66000	8	9	339	384	247	129

TABLE 25

METAL CONTENTS (úg/g) OF RIVER SEDIMENTS

	AL	Sb	Cd	Cu	Pb	Ni	Zn
	27000	<1	02.8	52.0	39.8	36.0	396
	20000	<1	01.2	31.0	23.3	49.0	259
	19000	<1	00.9	35.0	11.6	32.0	204
: Basin	18000	<1	01.10	35.0	22.8	31.0	233
Basin	16000	<1	00.50	39.0	19.5	35.7	168

ORGANIC CONTENTS (úg/g) OF RIVER SEDIMENTS

	BACKGROUND	DILUTION ZONE		OUTSIDE	INSIDE
	7NMFS	7.1	7.3	BOAT BASIN	BOAT BASIN
	0.5	0.2	<0.08	<0.1	<0.2
	<0.02	<0.01	<0.01	<0.01	<0.02
	0.4	0.3	0.25	0.1	0.5
	0.09	0.04	0.09	0.02	0.09
	1.5	0.6	0.6	0.4	0.6
	1	0.6	0.8	0.3	1
:ene	1	0.6	2	0.3	1
	0.8	0.7	3	0.3	1
ɛ	0.7	0.8	2.8	0.3	0.9
:hracene	<0.1	1.5	2.2	<0.1	<0.1
erylene	<0.1	0.8	2	0.3	0.2

TABLE - 26

FLOURIDE CONCENTRATIONS (mg/l) IN THE VICINITY OF
COMMONWEALTH ALUMINUM
DECEMBER 12 26, 1985

LOCATION	DEC 12	DEC 26
BACKGROUND		
7NMFS-S-1	<0.2	0.15
M-35	<0.2	
1-S-1'		0.14
M-13'		0.17
B-26'		0.14
2-S-1'	<0.2	
M-28'	<0.2	
B-57'	<0.2	
3-S-1'	<0.2	0.14
M-37'	<0.2	
B-74'	<0.2	
4-S-1'		0.15
M-11'		0.14
B-22'		0.17
DILUTION ZONE		
5-S-1'		0.15
M-12'		0.17
B-24'		0.17
6-S-1'	<0.2	0.12
M-23'	<0.2	
B-46'	<0.2	0.16
7-S-1'		0.15
M-13'		0.10
B-25'		
7-B-S		0.14
7-B-M		0.11
7-B-B		0.17
8-S-1'	<0.2	0.15
M-17'		0.14
B-33'	<0.2	0.14
9-S-1'	<0.2	0.13
M-17'	<0.2	0.14
B-35'	<0.2	0.10
FISH LADDERS		
NFL	<0.2	0.13
SFL	<0.2	0.14
DISCHARGES		

TABLE - 27

ORGANIC CONTENTS (úg/l) OF THE DISCHARGE AND RIVER WATERS
DECEMBER 12, 1985

S	DISCHARGE EFFLUENT	BACKGROUND 7NMFS	DILUTION ZONE 9M	9B	WATER QUALITY CRITERIA	COMPLIANCE
	<3	<3	<5	<5	620.0	YES
	<3	<3	<5	<5	0.031	*
	<0.5	<0.5	<0.8	<0.8	0.031	*
	<0.3	<0.3	<0.5	<0.5	0.031	*
	<0.6	<0.5	<1	<1	54.0	YES
	<0.3	<0.3	<0.5	<0.5	0.031	*
	<0.3	<0.3	<0.5	<0.5	0.031	*
	<0.3	<0.3	<0.5	<0.5	0.031	*
	<0.3	<0.3	<0.6	<0.6	0.031	*
ene	<0.6	<0.5	<1	<1	0.031	*
e	<0.6	<0.5	<1	<1	0.031	*

discussion

TABLE - 28

BENZO(a)PYRENE CONTENT (úg/l) OF DISCHARGES AND RIVER WATERS
DECEMBER 26,1985

LOCATION	BENZO(a)PYRENE
BACKGROUND	
7NMFS	0.4
DILUTION ZONE	
8S	<0.3
8M	<0.3
FISH LADDERS	
NFL	<0.3
SFL	<0.3
DISCHARGES	
Effluent	Sample destroyed
7 Creek	<0.03
8 Creek	Frozen - No flow
Water Quality Criteria	0.031
Max Observed	0.4
Compliance	*

* See text for discussion

TABLE - 29

METAL CONTENTS OF THE EFFLUENT
AND RIVER WATERS
DECEMBER 12, 1985

LOCATION	Sb	Ni	Al	Cu	Pb	Zn	Cd
	COMPONENT (ug/l)						
DISCHARGES							
Effluent	<10	31	186	6	17	9	<0.4
7 Creek	<10	69	663	14	25	47	1.5
8 Creek	<10	23	171	5	8	11	<0.4
BACKGROUND							
7NMFS	<10	20	86	3	8*	11	0.4
2M	<10	12	143	3	28*	11	<0.4
DILUTION ZONE							
8S	<10	42	143	6	14*	9	<0.4
9M	<10	11	114	4	11*	11	0.4
9B	<10	23	114	8	14*	13	<0.4
FISH LADDERS							
NFL	<10	11	100	5	3*		
SFL	<10	49	114	5	8*		
W.Q.C.	None	56	None	6.5	1.3	47.0	47.0
Compliance	Yes	Yes	Yes	Yes	No	No	Yes

DECEMBER 26,1985

LOCATION	Sb	Ni	Al	Cu	Pb	Zn	Cd
	COMPONENT (ug/l)						
DISCHARGES							
Effluent	<10	<12	343	<4	<3	<6	<1.8
7 Creek	<10	15	800	5	6	6	<0.4
8 Creek	Creek Frozen - No Flow						
BACKGROUND							
7NMFS	<10	37	71	5	17*	19	7.7*
DILUTION ZONE							

TABLE - 30

Sample Analysis for Cyanide, Chloride and Fluoride 1/

Facility	Location of Subsample	Total CN	Soluble Cl	Soluble F
Kaiser, Mead	Top	11,000	12,000	75,000
	Middle	32,000 2/	48,500 2/	27,750 2/
	Bottom	42,000	42,000	84,000
Kaiser, Tacoma	Top	7,500	28,000	88,000
	Middle	180	28,000	92,000
	Bottom	1,000	7,000	44,000
ALCOA, Vancouver	Top	1,700	2,100	67,000
	Middle	91	1,400	75,000
	Bottom	3,300	1,400	62,000
ALCOA, Wenatchee	Top	4.0	21,000	50,000
	Middle	7.0	11,000	29,000
	Bottom	7.2	21,000	32,000
Reynolds, Longview	Top	17	700	56,000
	Middle	18	700	140,000
	Bottom	250	700	250,000
Intalco, Ferndale	Top	6.3	70	26,400
	Middle	8.6	1,100	22,000
	Bottom	5.2	210	34,400
Martin Marietta, Goldendale	Top	27	1,400	15,000
	Middle	27	1,100	23,000
	Bottom	16	710	29,000

AV/C8(A2)

1/ All values reported as ppm.
2/ Two middle samples taken. Values reported represent the average.

EP Toxicity 1/ TABLE - 31

ocation of Subsample	Silver	Barium	Arsenic	Selenium	Chromium	Cadmium	Lead	Mercury
Top	0.04	<0.1	0.023	0.15	0.06	0.02	0.70	1.7
Middle	0.1 2/	<0.1 2/	5.54 2/3/	5.01 2/3/	0.06 2/	0.06 2/	0.95 2/	0.42 2/
Bottom	0.18	<0.1	2.2	1.07 3/	0.05	0.07	1.6	0.70
Top	<0.02	0.16	0.05	0.098	0.04	0.03	0.15	<0.02
Middle	<0.02	<0.1	0.05	0.037	<0.01	<0.01	0.02	<0.02
Bottom	<0.02	0.16	13.0 3/	37.0 3/	<0.01	0.01	0.25	<0.2
Top	0.04	<0.10	0.037	0.014	0.02	0.02	0.04	<0.2
Middle	<0.02	<0.10	0.11	0.045	0.02	0.02	0.02	<0.2
Bottom	0.08	<0.10	0.025	0.024	0.04	0.02	0.04	<0.2
Top	<0.02	<0.1	0.03	0.044	<0.01	<0.01	0.05	<0.2
Middle	<0.02	<0.1	0.04	0.062	<0.01	<0.01	0.20	0.42
Bottom	<0.02	<0.1	6.8 3/	17.0 3/	0.03	0.01	<0.02	0.28
Top	<0.01	<0.10	0.023	0.039	0.03	<0.01	<0.05	<0.2
Middle	<0.01	<0.10	0.036	0.070	0.04	0.01	0.10	<0.2
Bottom	0.10	<0.10	0.16	0.17	0.02	0.01	0.20	<0.2
Top	<0.02	<0.08	.021	.016	<0.01	<0.01	0.04	<0.2
Middle	<0.02	<0.08	.015	.014	<0.01	<0.01	<0.02	<0.2
Bottom	<0.02	<0.08	.036	.036	<0.01	<0.01	<0.10	<0.2
Top	<0.02	<0.10	<0.01	0.026	0.02	<0.1	<0.02	<0.2
Middle	<0.02	<0.10	0.053	0.014	0.02	<0.1	<0.02	<0.2
Bottom	<0.02	<0.10	<0.01	0.023	0.04	<0.1	<0.02	<0.2

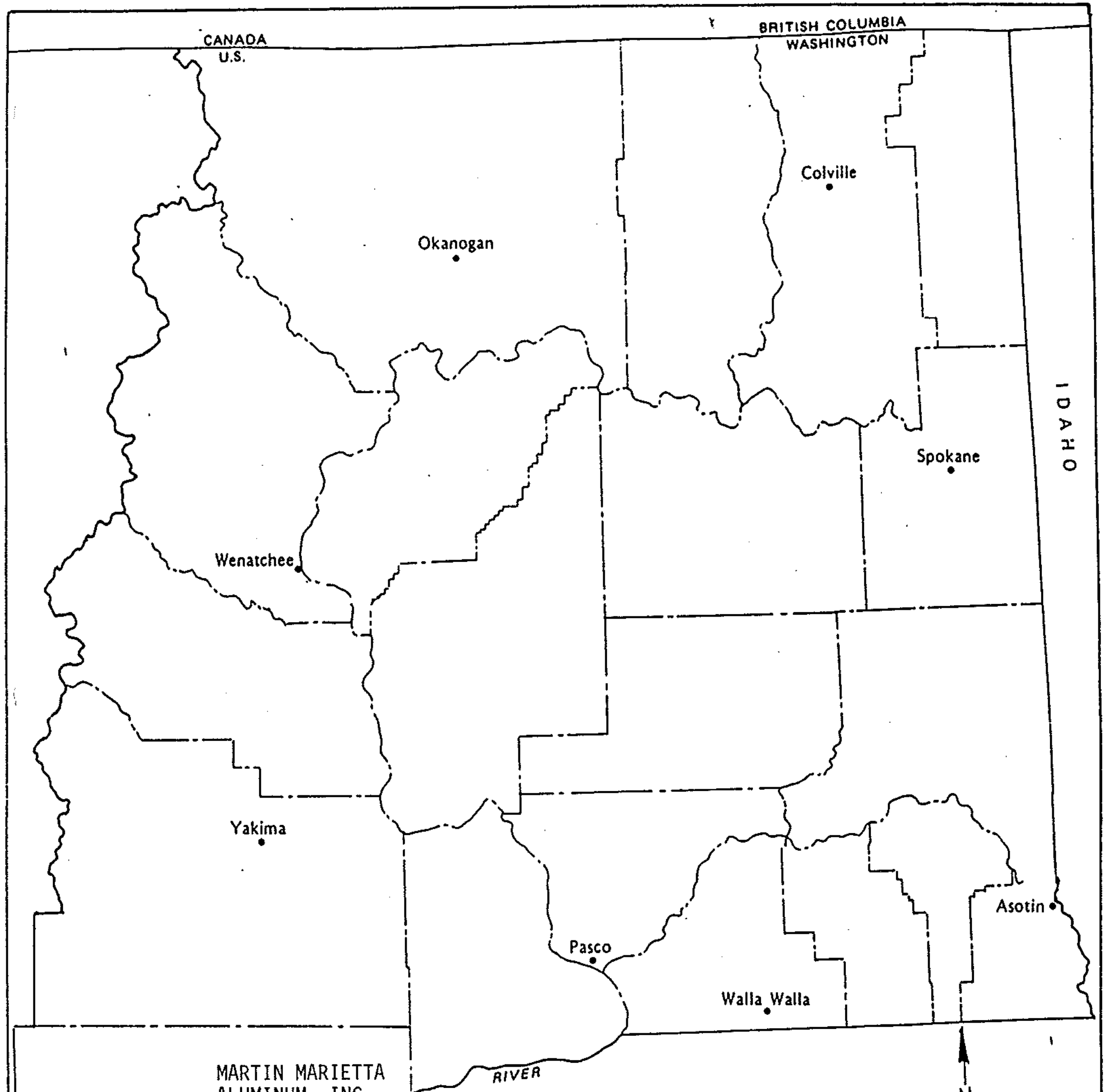
AV/C8(A3-4)

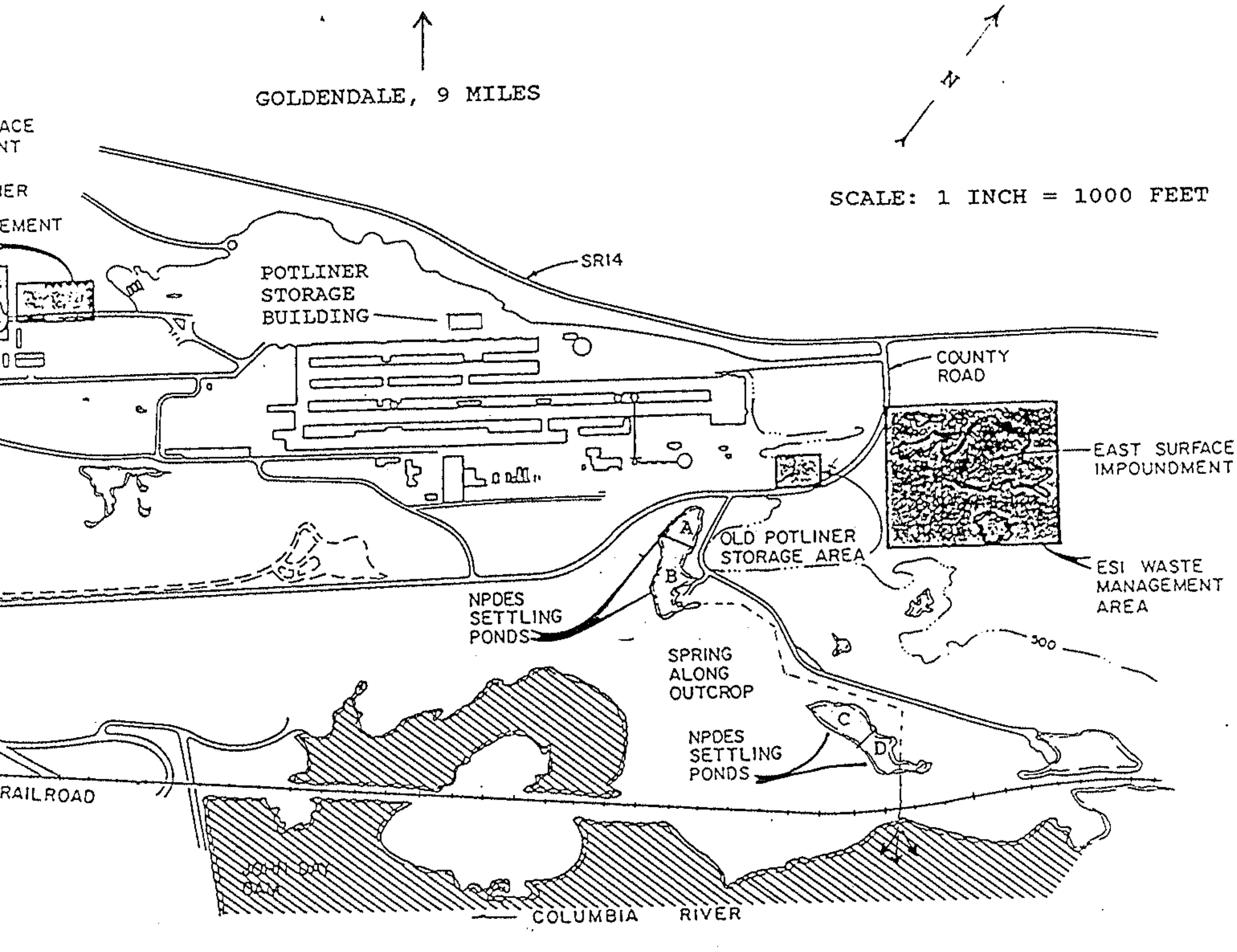
as mg/L except mercury which is reported as ppb.
aken, values reported represent the average.
is element.

TABLE - 32 Static Acute Fish Bioassay and Designation

ity	Location of Subsample	Dilution Factor/Percent Mortality		WDOE Designation
		100 ppm	1000 ppm	
ad	Top Middle Bottom	100% 100% 100%	100% 100% 100%	EHW
coma	Top Middle Bottom	100% 6.6% 100%	Not performed	EHW
couver	Top Middle Bottom	56.6% 3.3% 83.3%	Ran 1 tank with 100% mortality.	EHW
atchee	Top Middle Bottom	0% 0% 0%	0% 0% 0%	Not designated by this method.
Longview	Top Middle Bottom	6.6% 13.3% 16.7%	13.3% 6.6% 100%	Not designated by this method.
ietta,	Top Middle Bottom	0% 0% 0%	Ran 1 tank with 0% mortality.	Not designated by this method.
erndale	Top Middle Bottom	0% 0% 0%	0% 10% 10%	Not designated by this method.

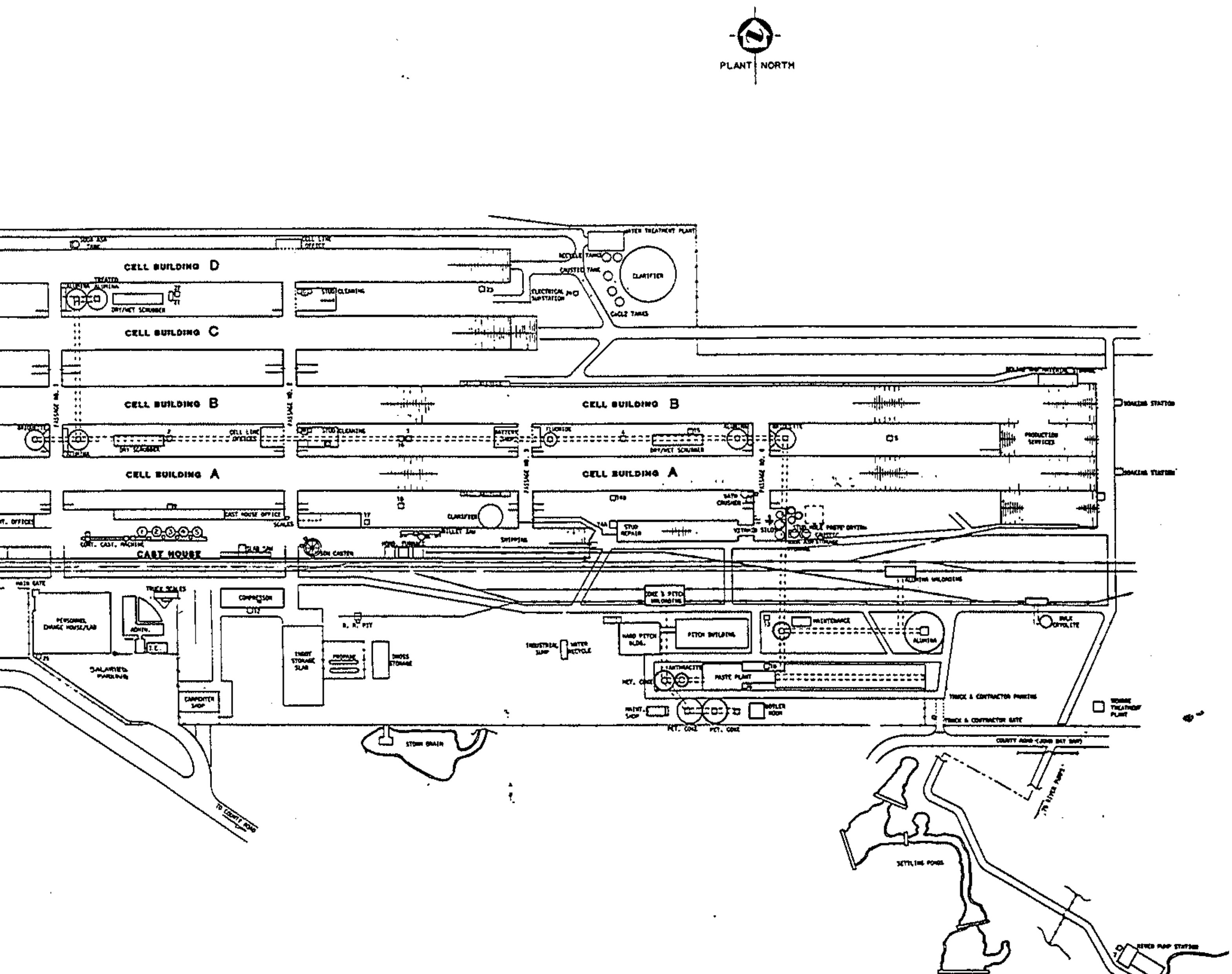
AV/C8(A5)


BRITISH COLUMBIA
WASHINGTON
CANADA
U.S.
Okanogan
Colville
Spokane
IDAHO
Wenatchee
Yakima
Pasco
Asotin
Walla Walla
RIVER
MARTIN MARIETTA



gure 1

RTIN MARIETTA ALUMINUM INC. SITE LOCATION MAP



GOLDENDALE REDUCTION PLANT FACILITIES

Rev.	Revision
1	ADDED HARD PITCH BLDG.
2	ADDED WETLAND, ROADS, CLOG 74
3	REMOVED CONS. TRAILERS
4	SALARIED PARKING
5	TO CWA

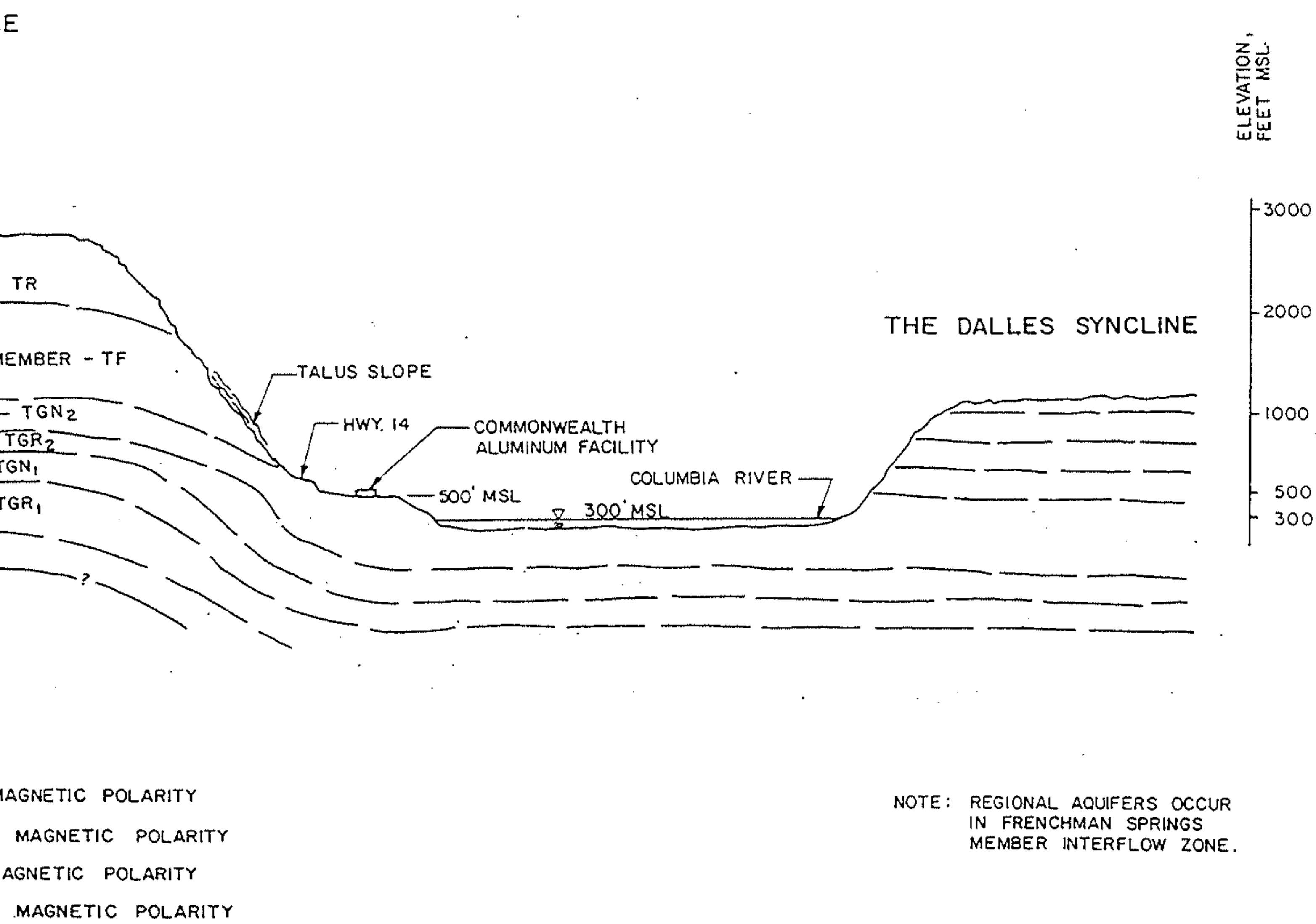
APPROVED FOR CONSTRUCTION

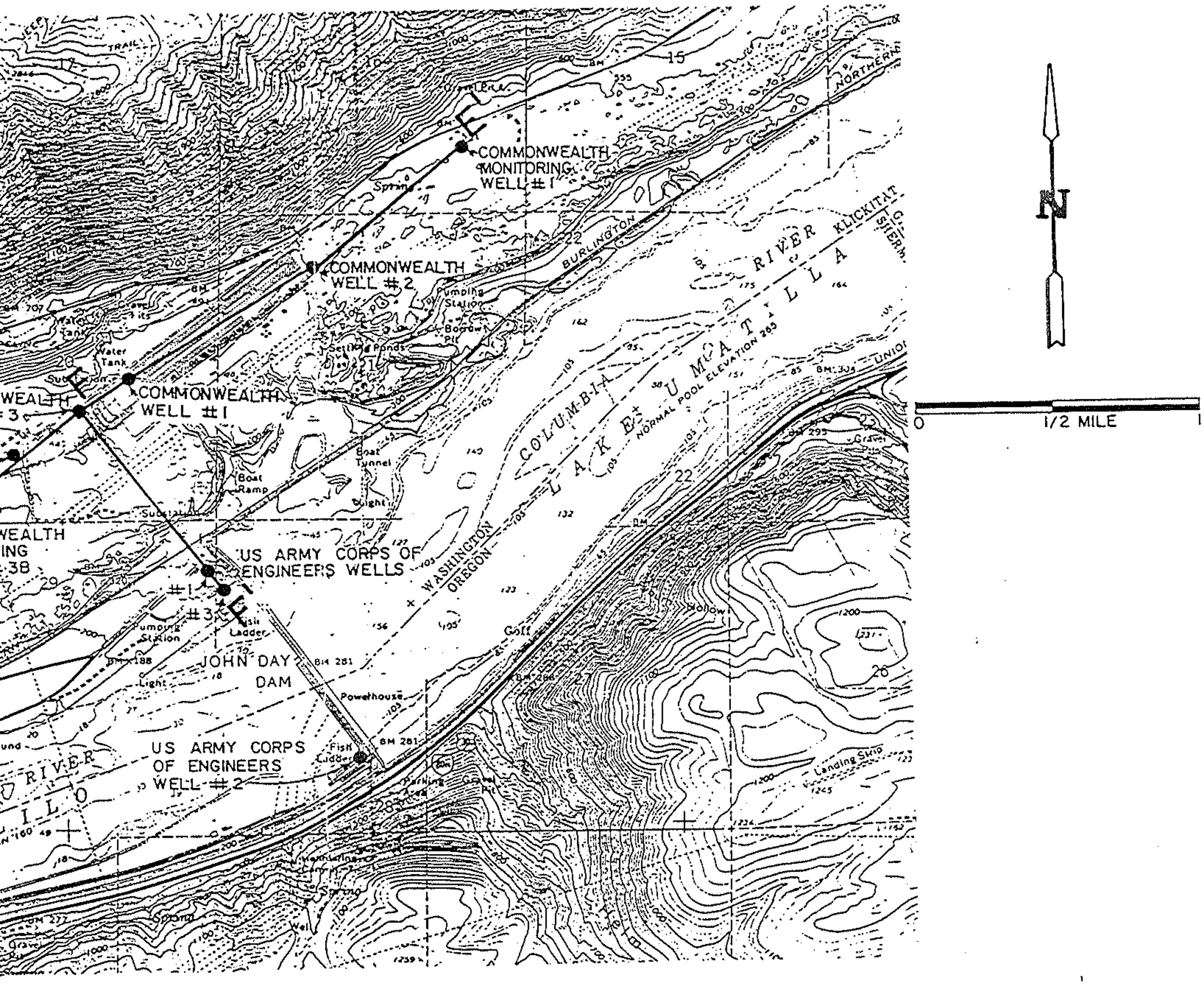
COMMONWEALTH ALUMINUM
GOLDENDALE REDUCTION PLANT

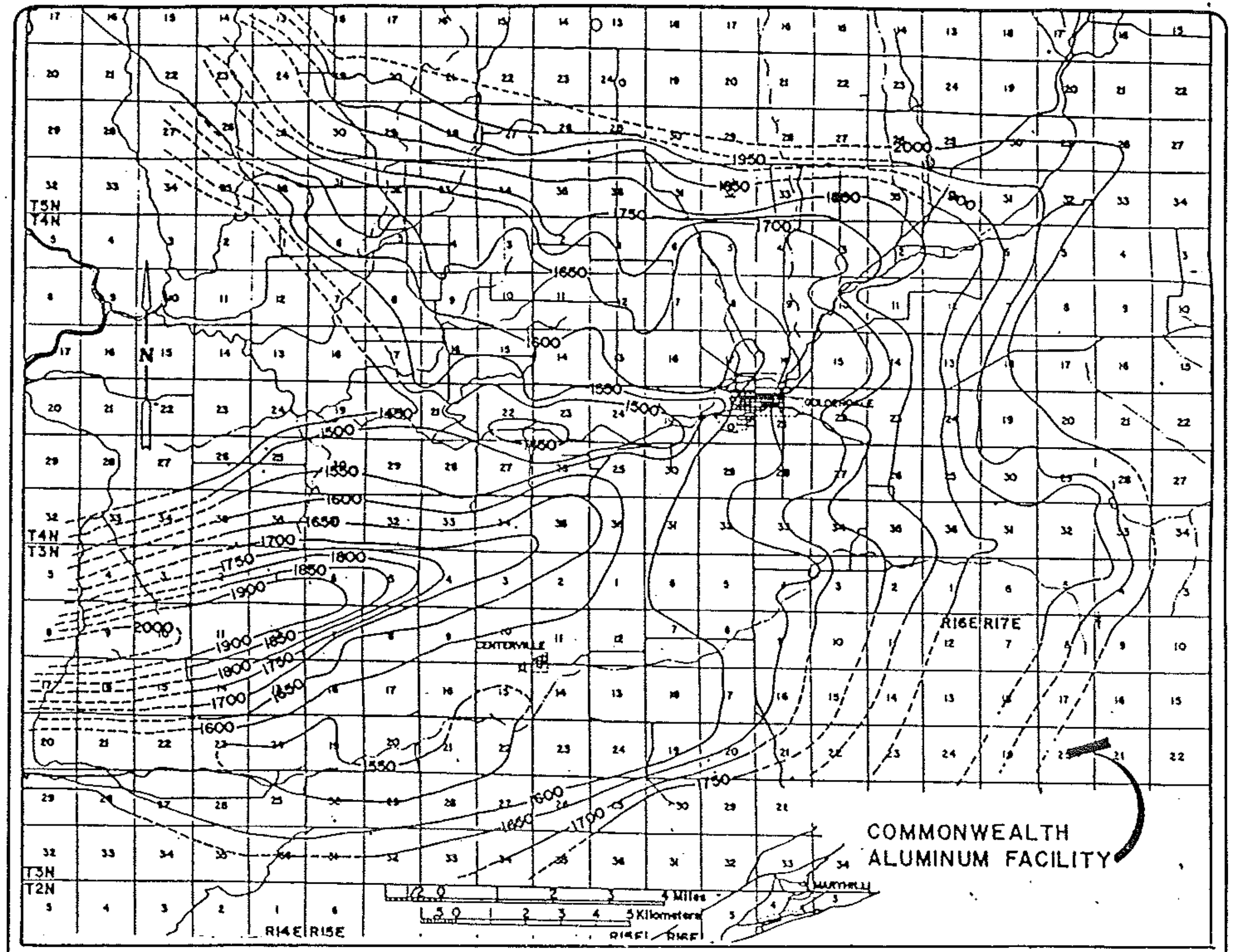
FACILITY- LAND & DEVELOPMENT
SUB FACILITY- SITE PLANNING

GOLDENDALE PLANT
PLAN VIEW

A0 8064


E
ELEVATION, FEET MSL
3000
2000
1000
500
300
THE DALLES SYNCLINE
TR
EMBER - TF
TALUS SLOPE
- TGN2
TGR2
GN1
TGR1
?
HWY. 14
COMMONWEALTH ALUMINUM FACILITY
500' MSL
300' MSL
COLUMBIA RIVER
AGNETIC POLARITY
MAGNETIC POLARITY
AGNETIC POLARITY
MAGNETIC POLARITY
NOTE: REGIONAL AQUIFERS OCCUR IN FRENCHMAN SPRINGS MEMBER INTERFLOW ZONE.


COMMONWEALTH MONITORING WELL #1
COMMONWEALTH WELL #2
COMMONWEALTH WELL #1
US ARMY CORPS OF ENGINEERS WELLS
#1
#3
JOHN DAY DAM
US ARMY CORPS OF ENGINEERS WELL #2
LAKE UMATILLA
COLUMBIA RIVER
WASHINGTON
OREGON
NORMAL POOL ELEVATION 265
KLICKITAT
BURLINGTON
NORTHERN
Pumping Station
Borrow Pit
Settling Ponds
Water Tank
Boat Ramp
Boat Tunnel
Powerhouse
Fish Ladder
Landing Strip
Hollow
Golf
Spring
N
0
1/2 MILE
1



LEGEND

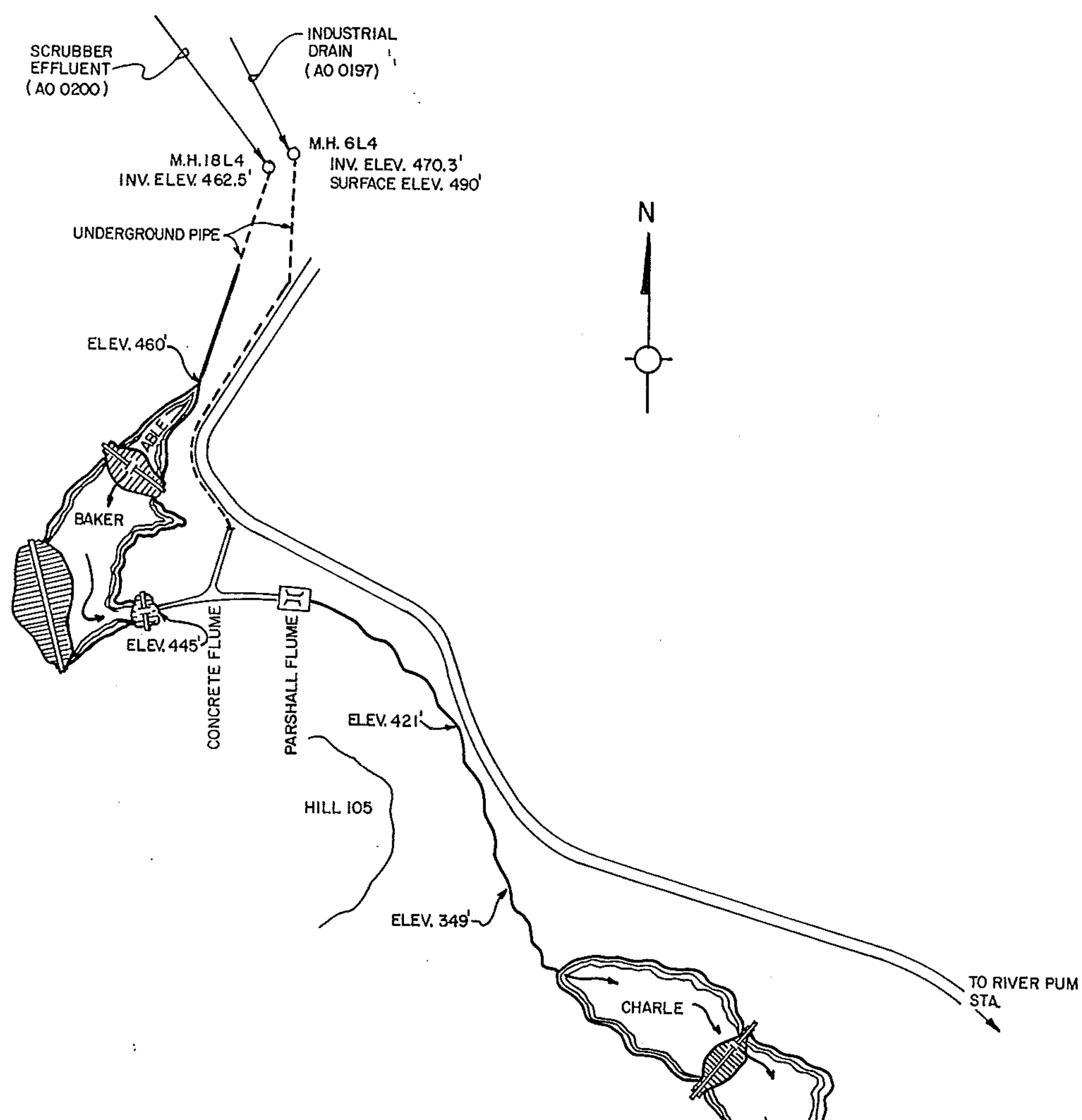
——1800—— CONTOUR LINE

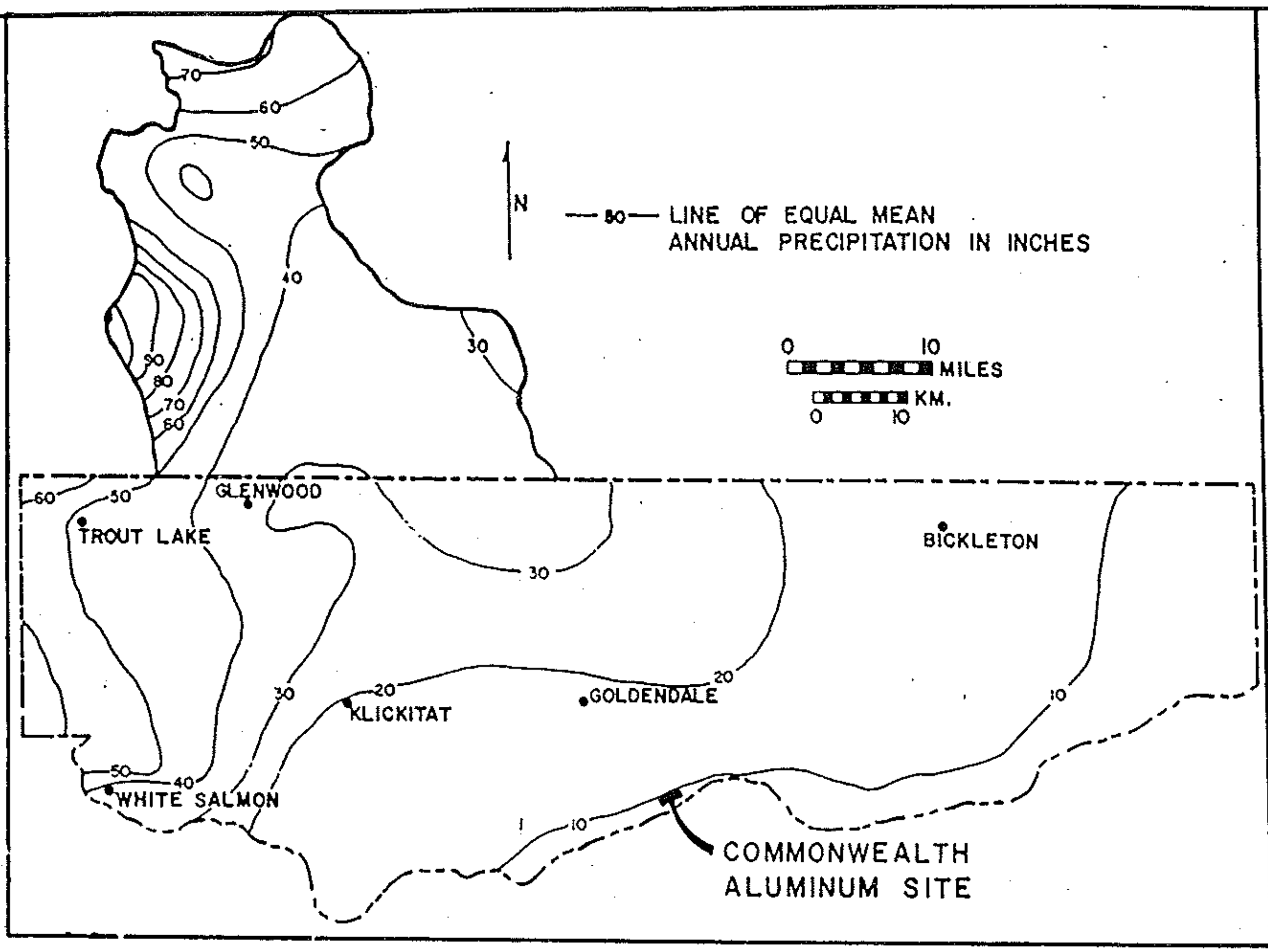
ADAPTED FROM GEOLOGY AND WATER RESOURCES OF KLICKITAT COUNTY WA., 1979

MEASUREMENTS RECORDED MAY 1974

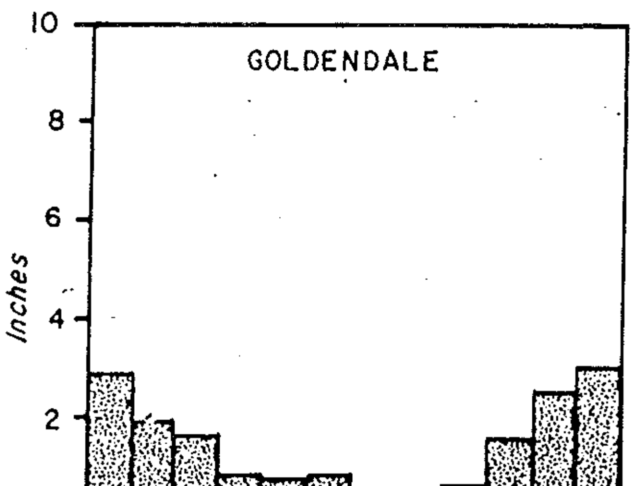
WATER-LEVEL CONTOUR MAP (FRENCHMAN SPRINGS INTERFLOW ZONE) OF THE GOLDENDALE - CENTERVILLE AREA (SPRING 1974), KLIKITAT COUNTY, WASHINGTON.

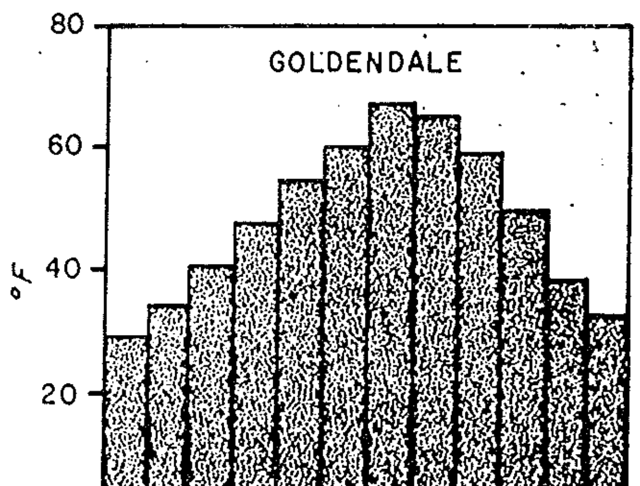
SURVEYING EQUIPMENT CO 94420

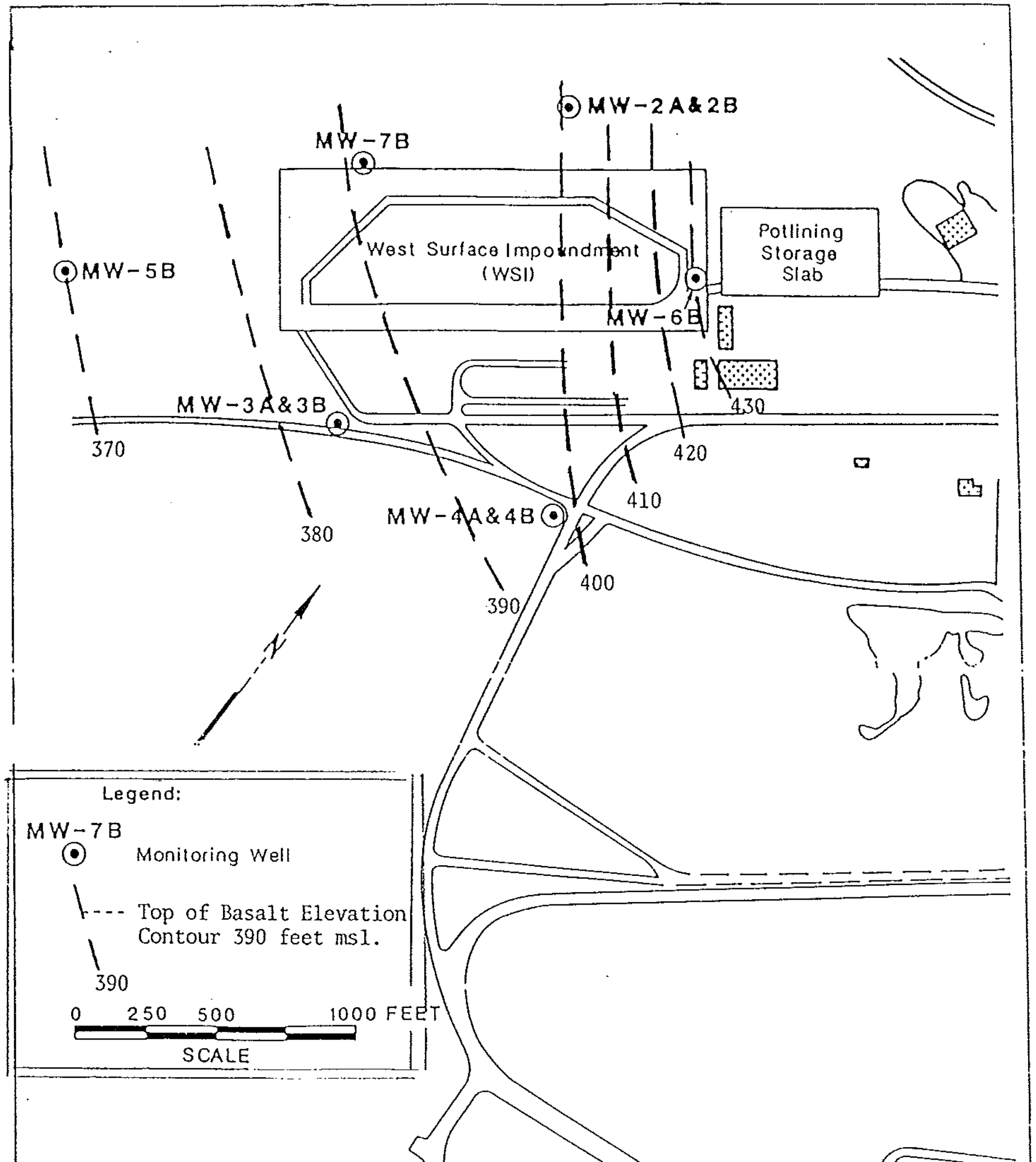

SCRUBBER
EFFLUENT
(AO 0200)
INDUSTRIAL
DRAIN
(AO 0197)
M.H. 6L4
M.H. 18L4
INV. ELEV. 462.5'
INV. ELEV. 470.3'
SURFACE ELEV. 490'
N
UNDERGROUND PIPE
ELEV. 460'
ABLE
BAKER
ELEV. 445'
CONCRETE FLUME
PARSHALL FLUME
ELEV. 421'
HILL 105
ELEV. 349'
CHARLE
TO RIVER PUM
STA.



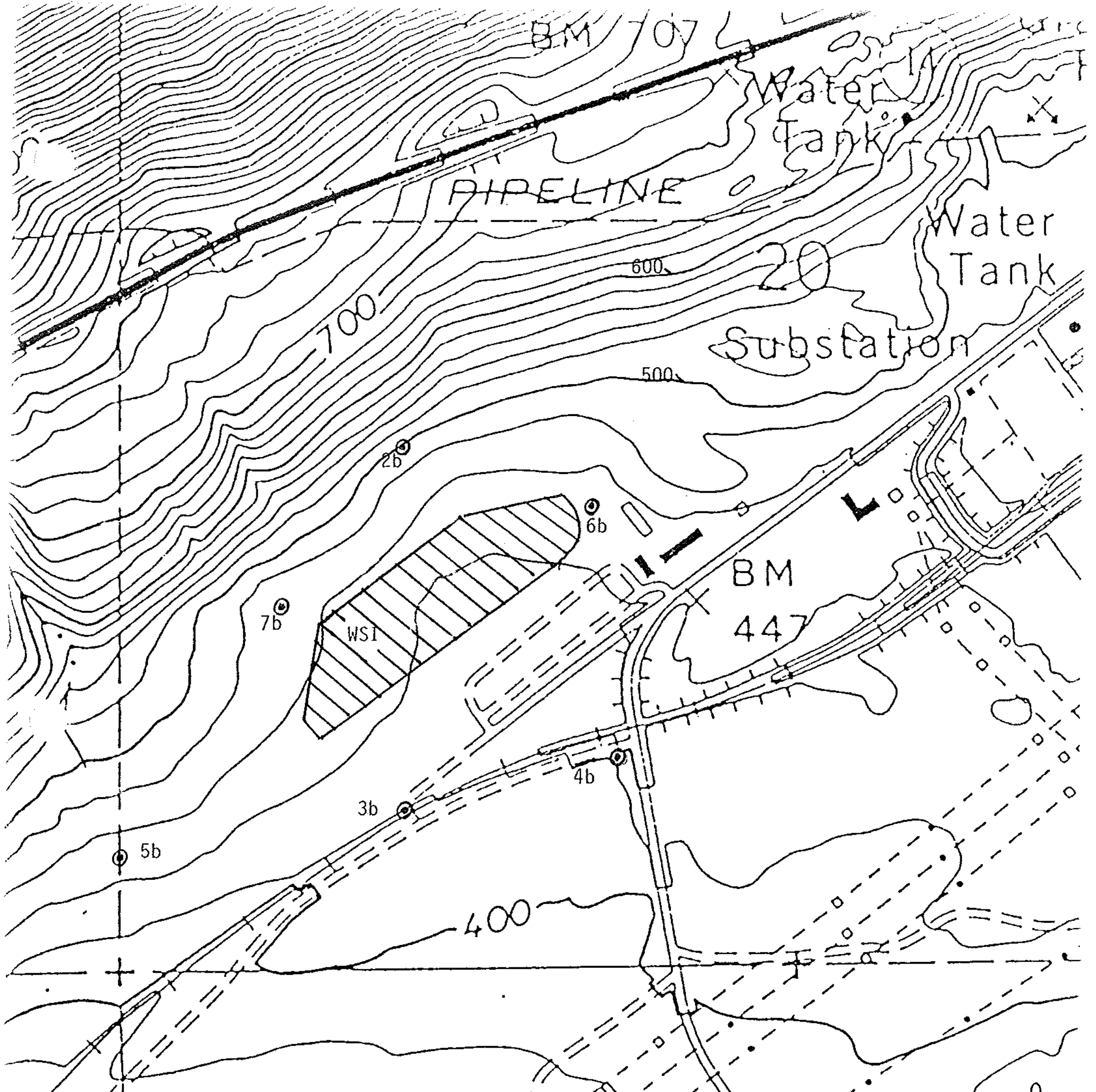
MEAN ANNUAL PRECIPITATION, KLICKITAT COUNTY & UPPER KLICKITAT PINE BASIN, WA.







MW-2A&2B
MW-7B
West Surface Impoundment
(WSI)
Potlining
Storage
Slab
MW-5B
MW-6B
430
MW-3A&3B
370
420
410
MW-4A&4B
380
400
390
N
Legend:
MW-7B
Monitoring Well
Top of Basalt Elevation
Contour 390 feet msl.
390
0 250 500 1000 FEET
SCALE


BM 707
Water Tank
PIPELINE
Water Tank
600
20
700
Substation
500
2b
6b
BM
447
7b
WSI
4b
3b
5b
400

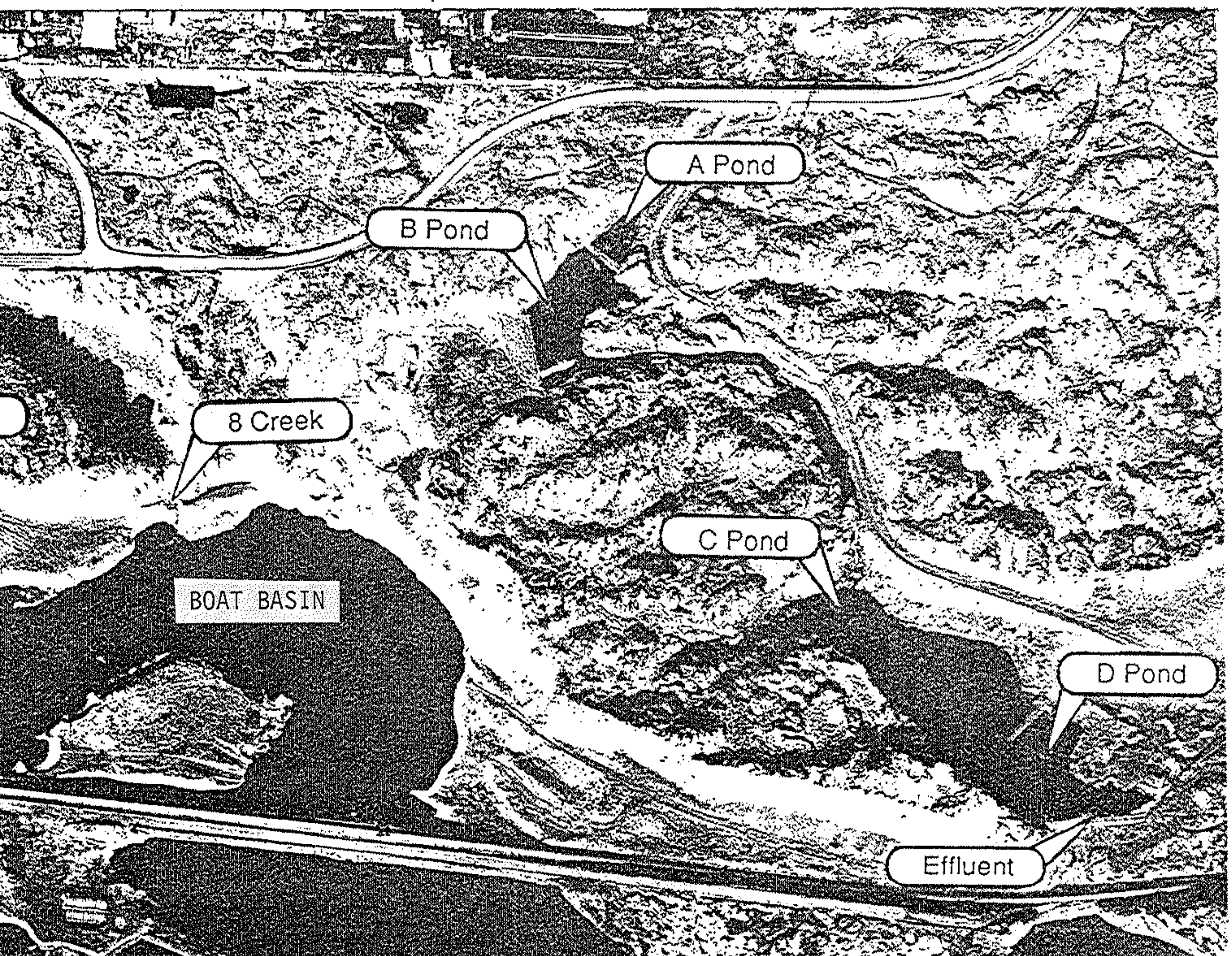
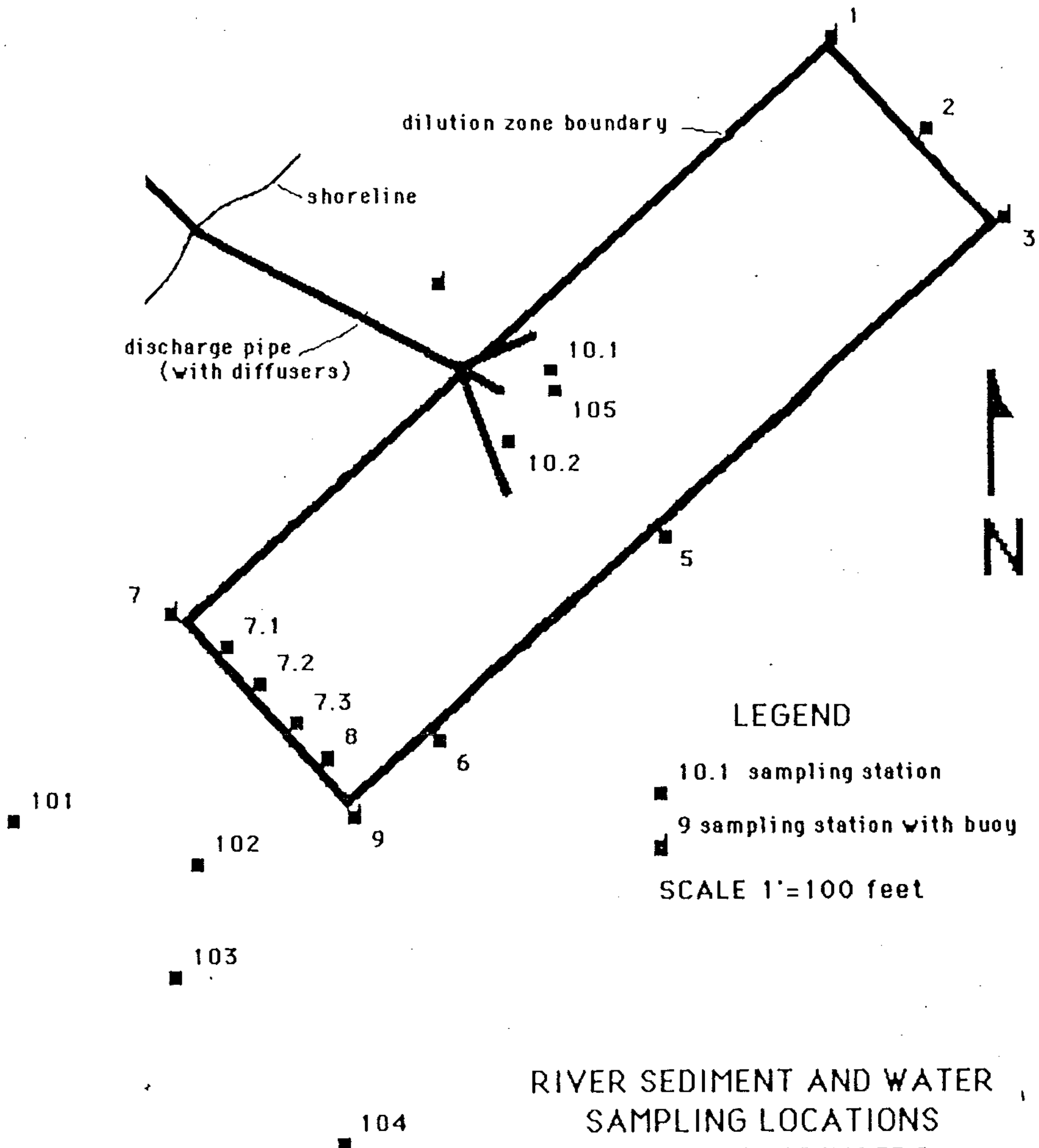
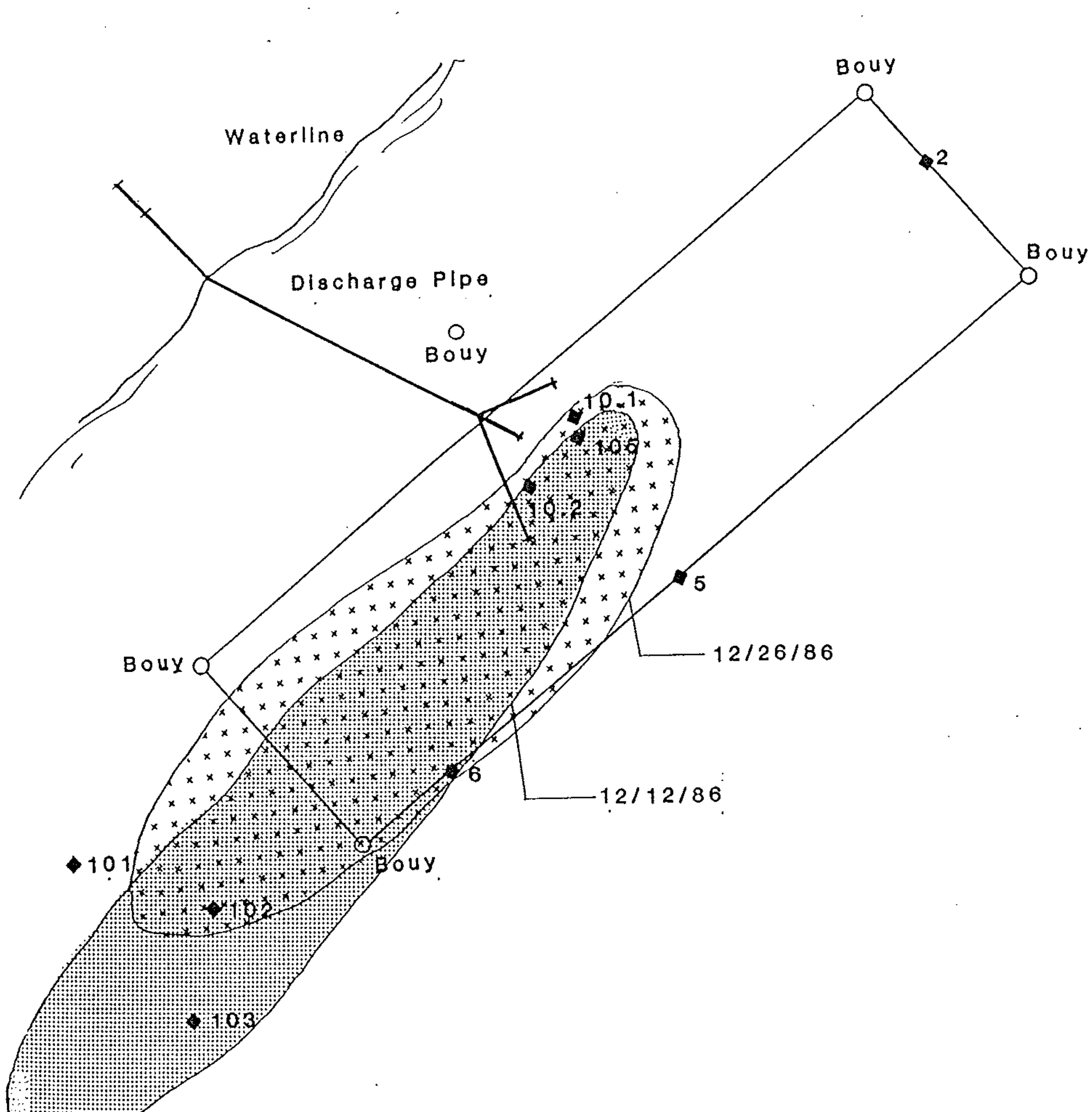


Figure 11
tewater Lagoon System and Discharge Sampling Locations



RIVER SEDIMENT AND WATER
SAMPLING LOCATIONS
NEAR THE DIFFUSERS


Waterline
Discharge Pipe
Bouy
Bouy
Bouy
Bouy
Bouy
2
5
6
101
102
103
105
10.1
10.2
12/26/86
12/12/86

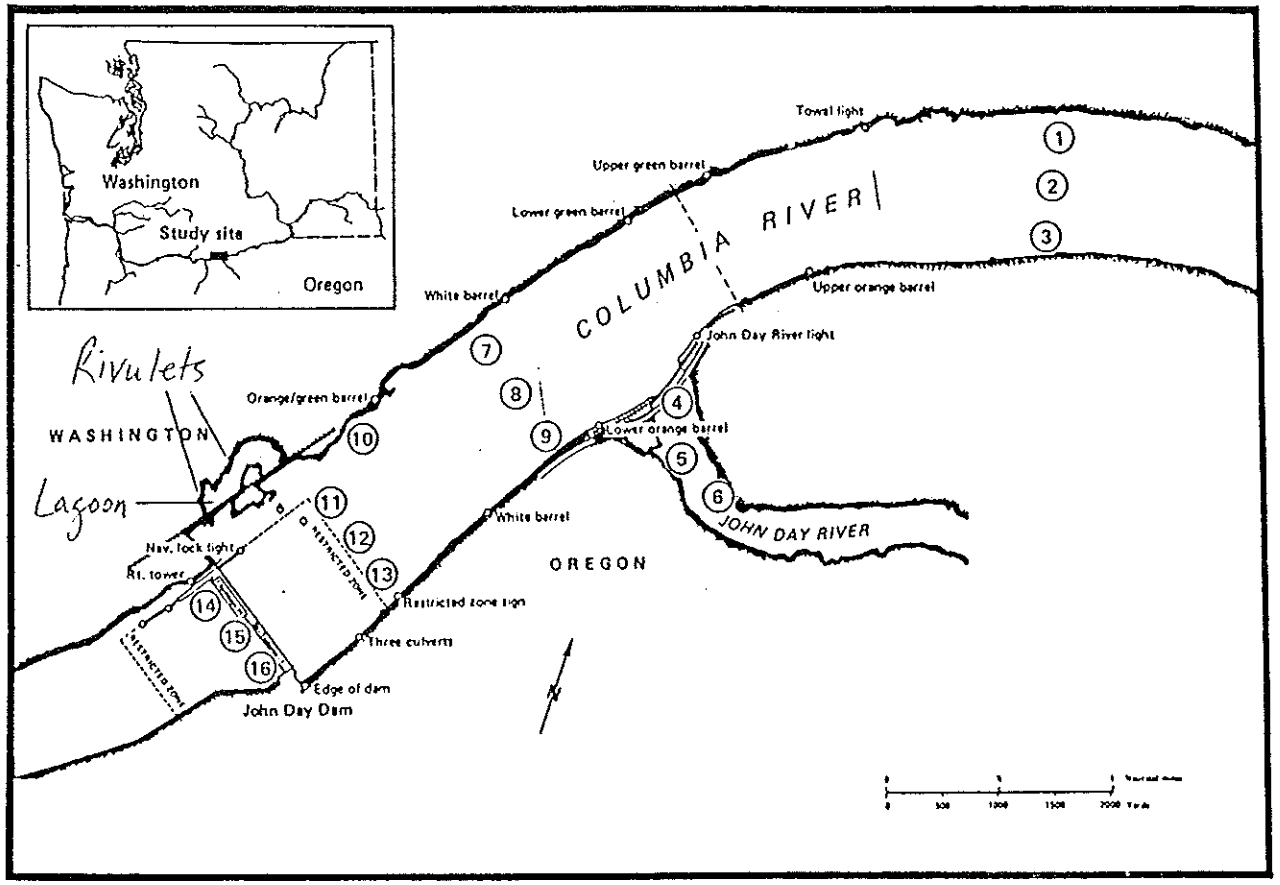
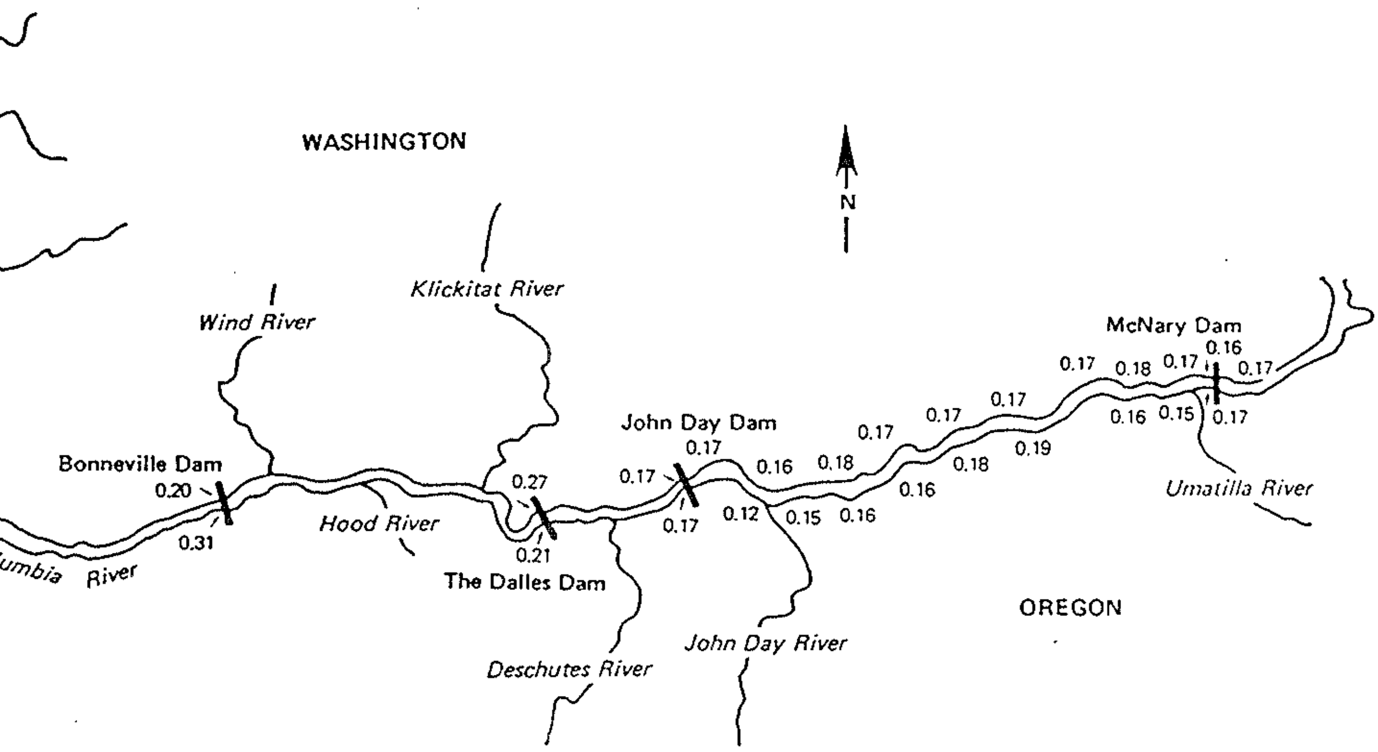


Figure 14 - Study area for adult salmonid passage-delay program, John Day Dam



ace fluoride distribution (ppm) in the Columbia River from Bonneville Dam to McNary Dam,
1983.

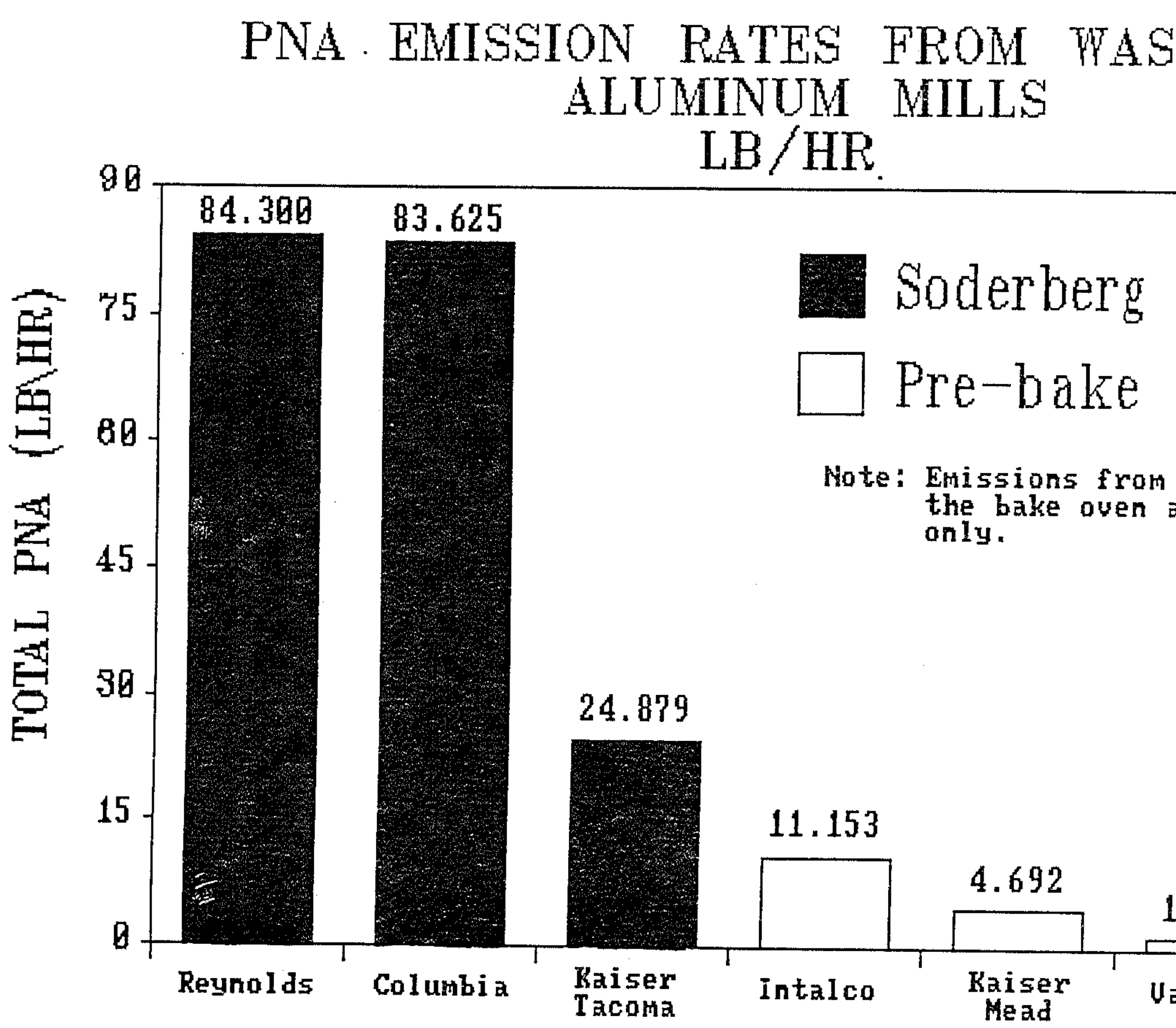
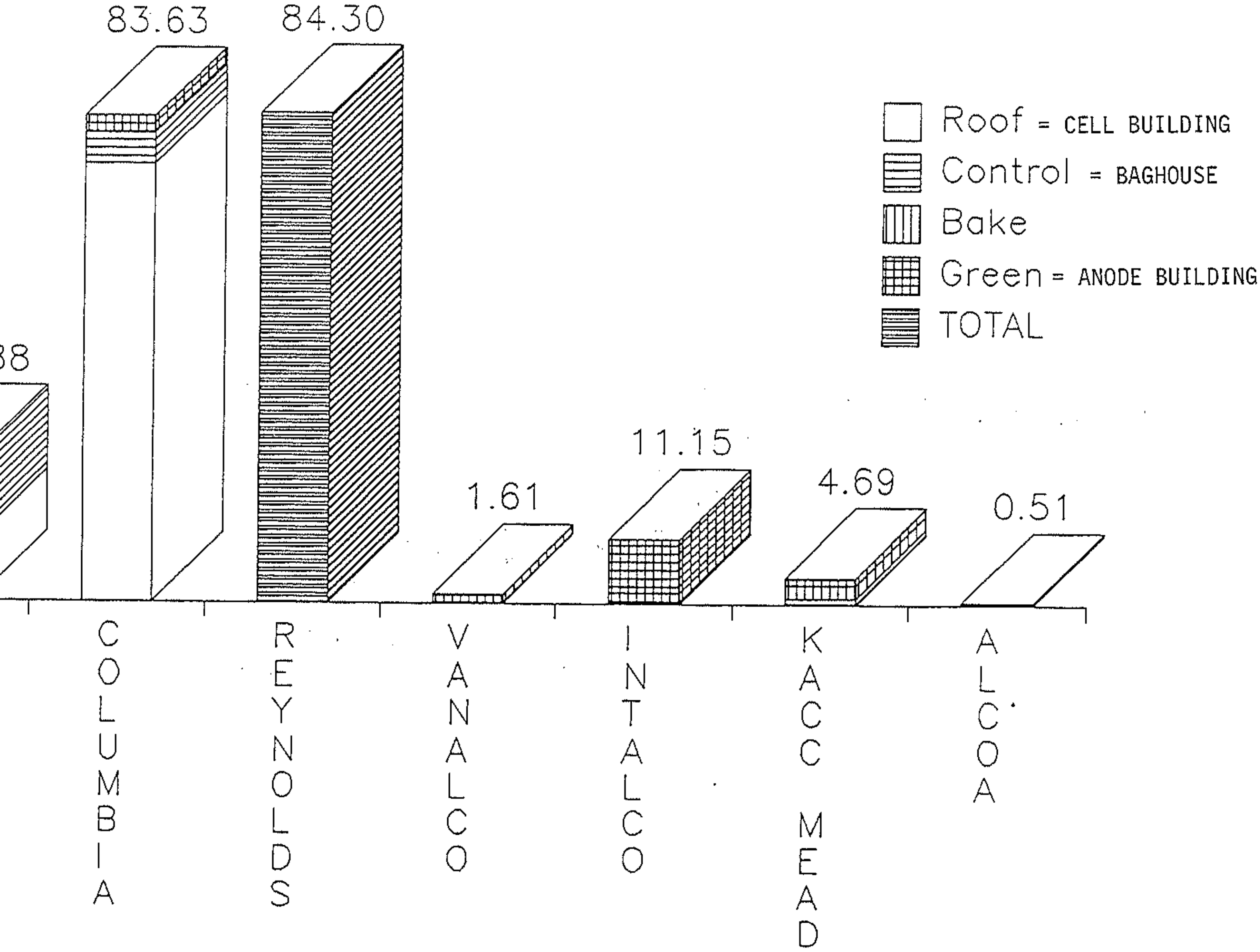
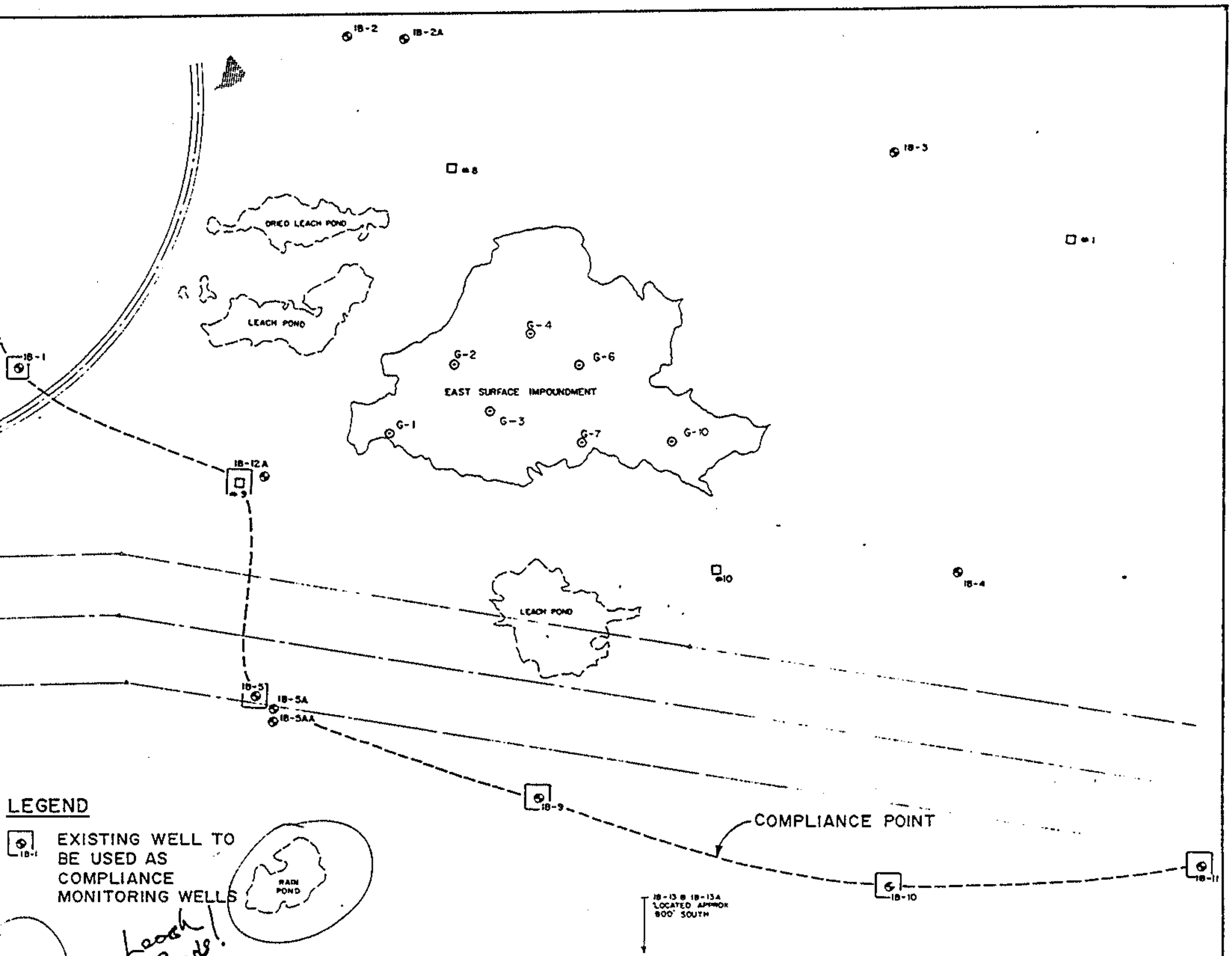

PNA EMISSION RATES FROM WAS
ALUMINUM MILLS
LB/HR
TOTAL PNA (LB\HR)
90
75
60
45
30
15
0
84.300
83.625
24.879
11.153
4.692
Soderberg
Pre-bake
Note: Emissions from
the bake oven
only.
Reynolds
Columbia
Kaiser Tacoma
Intalco
Kaiser Mead

Figure 16

ALUMINUM PLANT PNA EMISSIONS





REVISIONS				
NO	BY	APPVL		DATE

DESIGNED BY	DATE FEB 1986
DRAWN BY PAM	SCALE 1" = 100'
CHECKED BY	SEC
DRAWING NO 600400305	

POST CLOSURE COMPLIANCE MONITORING WELLS

Commonwealth Aluminum, Goldendale Facility
ESI Closure and Post Closure Plans

Century West Engineering

FIGURE

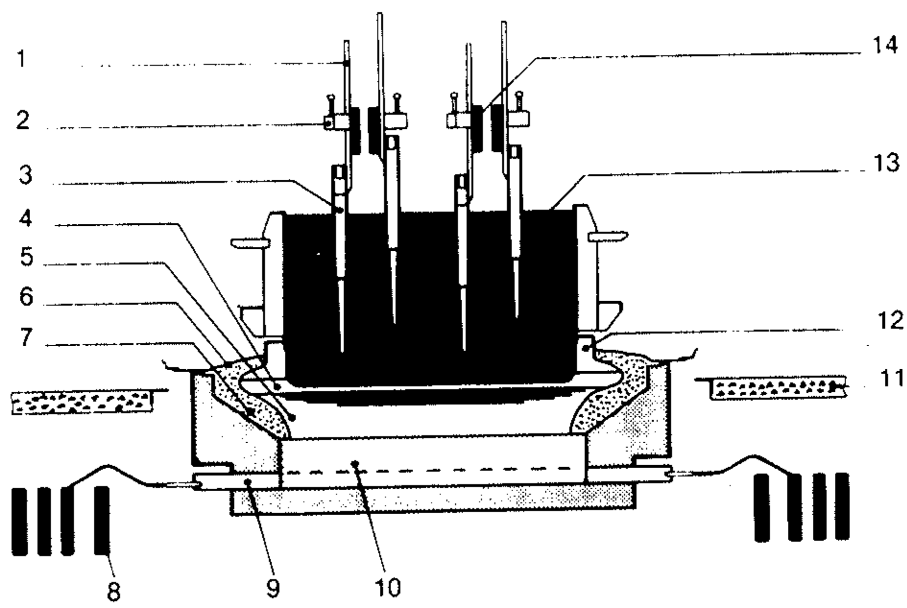
natic diagram of an
fitted with a "Söder-

anode riser
olding clamp
el anode pins

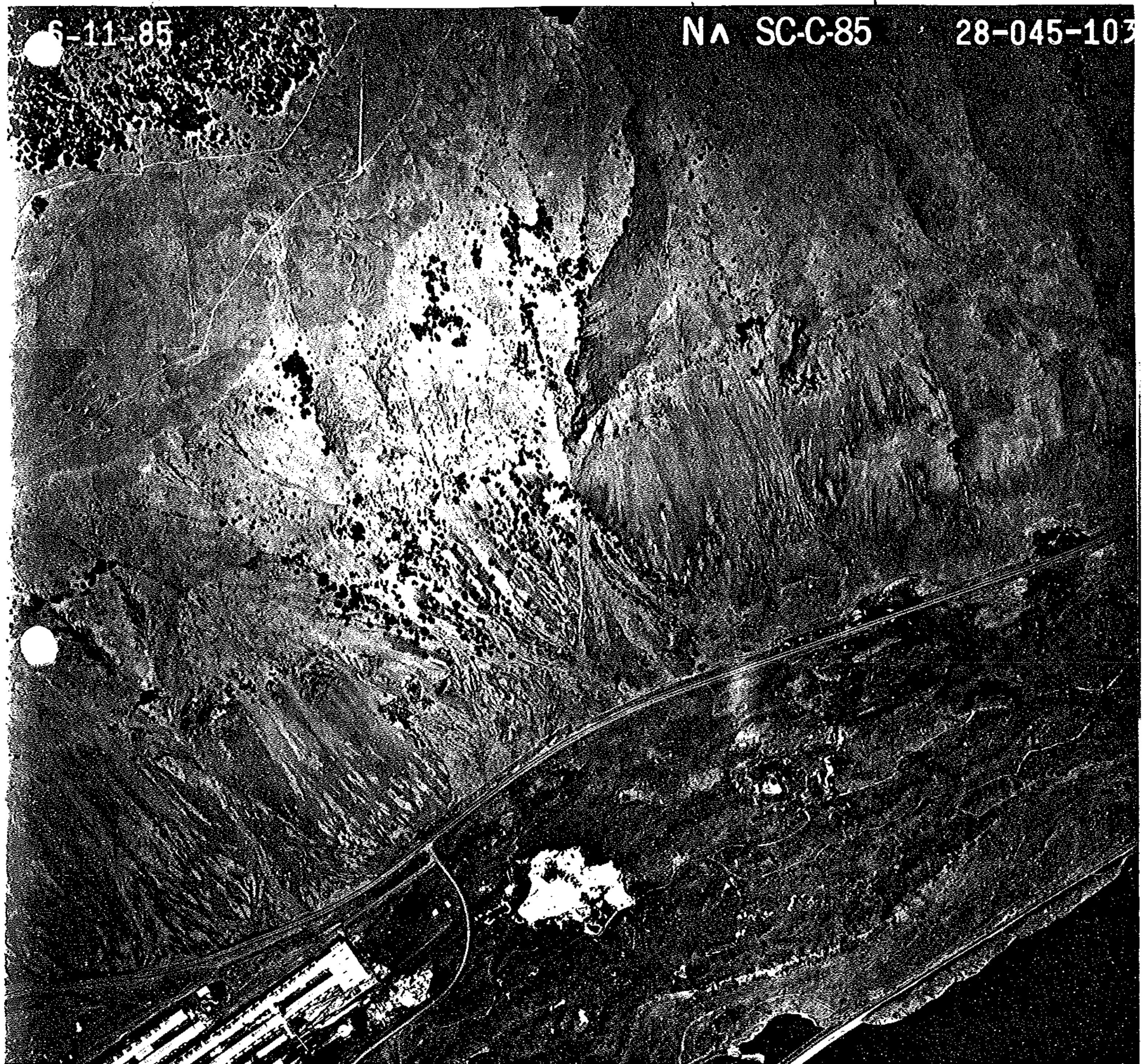
nium

n bath)
s bar
lector bar
ode block

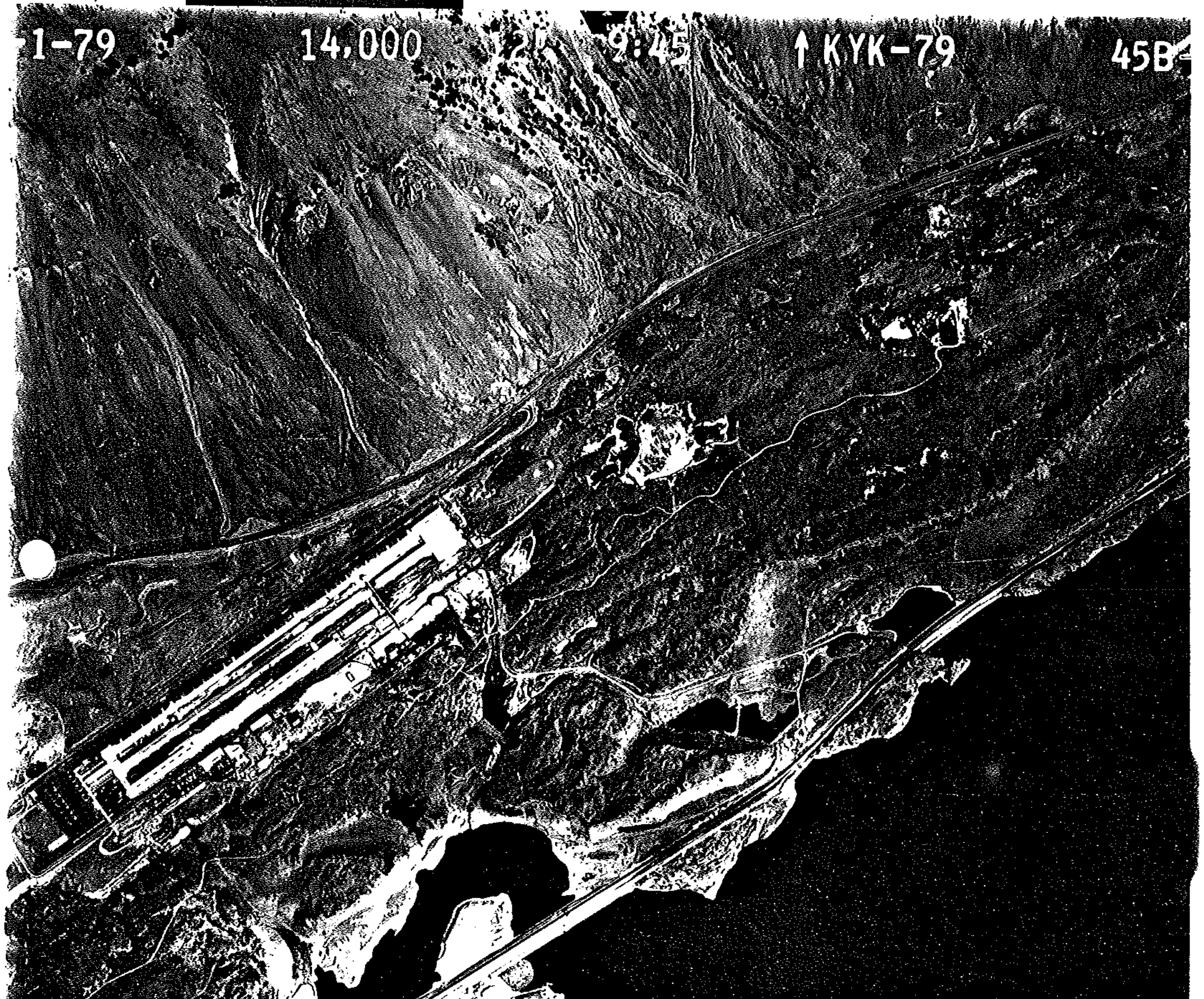
on skirt
' anode
bar.




8-1-86
N
SC-H-86-3 17E-6


6-11-85
N∧ SC-C-85
28-045-103

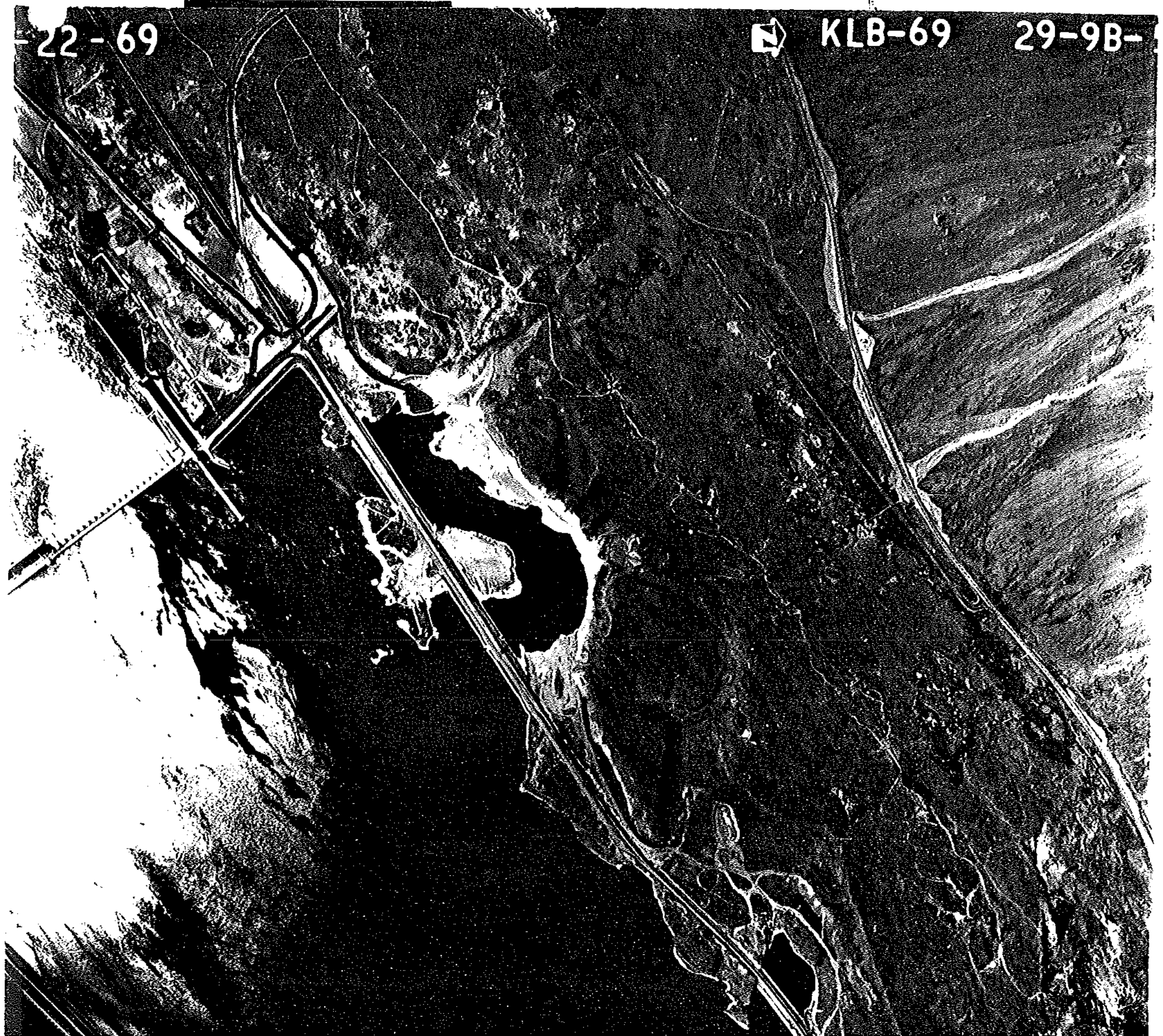

6-11-85
N^ SC-C-85
28-044-143


1-79
14,000
9:45
KYK-79
45B


-22-79
↑ KYK-79
44A-


7-14-77
SC-C-77 22A-4

[redacted]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