Presented and published in the proceedings of the National Seminar on "Environmental and sociological Implications of Mining (Coal, Limestone and Uranium) and exploitation of Oil and natural gas in North – East India", North – East India Council for social Science, Shillong; Jun. 5-6, 2003

URANIUM MINING, MILLING AND TAILINGS DISPOSAL – BEST PRACTICES

by

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Uranium Corporation of India Ltd.

Abstract

Uranium is the basic raw material for the nuclear programme of the country. With the formulation of Atomic Energy Programme in 1948, the search for uranium ore had commenced. Very soon, several occurrences in different parts of the country were brought to light. The exploitation of this valuable ore is now being carried out by Uranium Corporation of India Ltd. The ore is being mined at three underground mines located in the district of Singhbhum East of Jharkhand state and treated in a common mill. After extraction of uranium, the fine tailings are contained in a tailings pond.

The technology adopted by UCIL in mining, milling and containment of waste in tailings pond is comparable with the best practiced anywhere in the world. It is based on the large experience, extensive research out-put, technical know-how and enormous expertise available in the country. UCIL is now expanding its production capacity by opening new uranium mines and process plants in Singhbhum and other parts of the country.

Amongst the operating mines of UCIL, Jaduguda is now the oldest and the deepest underground mine of the country with the best operating practices. Narwapahar mine is the most modern one with the introduction of trackless mining. It is a state-of-the-art technology followed first time in the country.

The mill at Jaduguda is one of the most inventive hydrometallurgical plants with unparallel track record of capacity utilization and safety. It houses various automatic process control systems and monitoring equipment. The mill has been expanded twice with in-house expertise. The unit is an excellent pool of technical and scientific manpower having unique experience of commissioning and operating hydro-metallurgical plant.

The tailings pond constructed by UCIL and expanded subsequently in two phases is a well-engineered impoundment facility having utmost consideration for environment and provision for treatment of effluents. The environmental monitoring results around tailings pond signify the soundness of the design criteria and reliability of the practices.

At UCIL units of Singhbhum, it is an exemplary display of art of science that has fashioned the future of thousands of local inhabitants beaming with the benefit of nuclear industry.

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Introduction:

With the formation of Atomic Energy Commission in India in 1948, a marked beginning was made in the country for the ambitious atomic energy programme. Consequent to this development, it was felt that the country must have indigenous resources of basic raw material i.e. uranium. A group called Raw Materials Division was formed to survey and locate good uranium deposits. During this period (early fifties), not much of information on uranium exploration was available. Hence, the first emphasis of search was laid on the existing mineral belts and geologically favourable areas. Association of uranium with copper and gold was known in some parts of the world. On the same analogy, the copper belt of Singhbhum (in former Bihar, presently in Jharkhand) and Rajsthan and gold fields of Kolar (in Karnataka) were searched. The pioneering work of the first group of geologists, brought to light many uranium occurrences in Singhbhum Thrust belt and it became evident that this belt holds the promise for uranium potential. Jaduguda in Singhbhum Thrust Belt is the first uranium deposit to be discovered in the country in 1951 and exploratory mining activities commenced in this deposit in 1957. Subsequently, quite a few more deposits were also located in this region.

In Oct 1967, Uranium Corporation of India Ltd, a public sector enterprise under the administrative control of Department of Atomic Energy was formed with an objective to mine and process uranium ore in the country. At the time of formation, the corporation had only one underground mine at Jaduguda in the Singhbhum East district of Jharkhand and a process plant near the mine. The activities of the corporation has expanded manifold during these years with addition of some more operating units.

During last five decades, with the increasing need of energy for the accelerated agricultural and industrial growth, the Atomic Energy Programme of our country has gained considerable momentum. Consequently, the facilities are being built-up to augment the uranium production. The new areas with the potential of large good grade uranium reserve have been located in different parts of the country and production centers are being constructed by UCIL in some of those areas.

Operations of UCIL:

Uranium Corporation of India Ltd. is in the front end of nuclear fuel cycle in accordance with its objective of producing and meeting the uranium requirement of the country. In the pursuit of this endeavour, the corporation has attained a very special standing amongst comparable industries with regard to its core activities. Following activities are considered the mainstay of UCIL's operation.

a) **Mining of uranium ore**
b) **Milling of the ore to extract uranium**
c) **Management of the tailings**

Achieving excellence in preaching best practices has been made possible in each of the above areas by –

a) Adopting modern, relevant and proven technology
b) Up-grading the existing practices
c) Stringent monitoring
d) Optimising the economics

Mining of uranium ore: Mining of uranium ore has remained central to UCIL's activities since its formation.

Existing mines

There are now three underground uranium mines being operated by UCIL in the district of Singhbhum East, Jharkhand.

The underground mine at **Jaduguda** is in operation since 1967. The entry into the mine is through a vertical shaft. The mine has been deepened in three phases. It is now 905m deep. **Bhatin** is a small mine 3 km west of Jaduguda. It is in operation since 1986. The reserve of this deposit is very small with limited production potential. **Narwapahar** mine is one of the most modern underground mines of the country located 12 km west of Jaduguda. It was commissioned in 1995 with the state-of-the-art technology and use of large trackless underground equipment. Narwapahar is comparatively a large mine with high production capacity.

New mines

As the Company has undertaken expansion plan to augment its uranium production capability, construction of following new mines has been taken up in different parts of the country.

a) Underground mine at Turamdih in the district of Singhbhum East, Jharkhand – This mine is already under development. The work is ahead of schedule.
b) Opencast mine at Banduhurang in the district of Singhbhum East, Jharkhand .
c) Underground mine at Bagjata in the district of Singhbhum East, Jharkhand .
d) Two underground mines and two opencast mines in Nalgonda district, Andhra Pradesh
e) Two opencast mines in West Khasi hills district, Meghalaya

Mine planning & development: Mine planning and design is the key to success of any major mining venture. All the existing mines of UCIL are well planned with design inputs from reputed consultants, experts, educational & research institutes and in-house professionals. Before undertaking the mining operations, various laboratory and site tests are conducted and the inputs thus generated form the basis for mine design. Recently, some state-of-the-art integrated software are in use in each of the existing mine sites. The proposed mines are also being designed with these software and modeled with various geo-technical and financial parameters. With the progress in mine development, the existing models will be up-graded with additional in-puts. This helps in visualising the mine in advance at every step of design.

Mine entry: Mine entry is a crucial component in any underground mines. Selection of proper entry system plays the vital role in productivity. In Jaduguda mine, a 640m deep vertical shaft provides entry into the mine. This vertical shaft was constructed in 1967 which is a landmark achievement being completed in record time adopting slip-form system of lining practiced for the first time in the country. The tower-mounted, multi-rope, double-drum Koppe winder in use at Jaduguda is the only one of its kind in the country with several built-in safety measures. Recently, Jaduguda mine has been deepened to 905m by constructing an underground shaft at a depth of 555m.

The entry into Narwapahar is through a 7^0 gradient decline extended upto a depth of 185m. This facilitates the use of large trackless equipment. A vertical shaft has also been sunk at

Narwapahar upto a depth of 355m in collaboration with Russian experts. The shaft sinking was completed in a record time in a very adverse hydro-geological condition.

Stoping: Though different stoping methods are tried at different period of time in different mines of UCIL, mechanized cut-and-fill method is now widely practiced in all the three mines optimising the ore recovery and dilution. The loading and transportation of broken rock from stopes to surface are completely automated. In Jaduguda and Bhatin mines, the broken ore in the stope are dumped into the ore pass by LHDs and they are collected in the main level through pneumatic chute. In Narwapahar mine, trackless diesel LHDs move directly into the stope to lift the broken rock. Deslimed mill tailings is used as the backfill material. The little amount of waste rock generated in the process of development and stoping are also disposed off in stopes as filling material. The activities are well planned and sequenced so as to maximize the productivity of stopes. Stopes of Narwapahar mine are accessed through ramps that helps in movement of trackless equipment to the working faces.

Machineries: Underground mining is a very strenuous job. The corporation always gives high priority to introduce modern machineries in different working areas making the entire operation of all the three working mines very safe and productive. Drilling is primarily carried out by pneumatic jack-hammer drills in Jaduguda and Bhatin mines. In Narwapapaher mine, diesel driven jumbo drills are mostly used. Transportation of broken rock in Jaduguda and Bhatin is normally carried out by diesel powered locomotives. Large trackless dumpers are used in Narwpahar mine for hauling of broken rock. UCIL has the distinction of introducing the use of CAVO, Alimak raise climber etc in Jaduguda for the first time in the country. In this regard, Narwapahar is the first mine in the country, where all the mining operations are automated with the introduction of large trackless equipment like drill jumbo, passenger carrier, road grader, scissor lift, lubricant truck etc. This has resulted in complete elimination of direct handling of ore. New underground uranium mines planned by UCIL at different places shall more or less adopt this technology with the introduction of upgraded versions of these machineries. The computerized break-down maintenance system in practice at existing mines helps in optimizing the spare parts inventory and maximising the productivity of these machinaries

Ventilation: The ventilation requirement of underground uranium mine need to be specially designed as the radioactive ore generates a gaseous element called radon. Adequate care is taken in the planning stage for supply and coursing of fresh air in each working place. With the gradual development and deepening of mine, fresh air requirement of each of the mines

are time-to-time re-assessed, ventilation circuits are simulated and measures are taken to implement the requirements on priority. All the underground mines of UCIL are very well ventilated with the provision for adequate quantity of fresh in-take air. The development faces are ventilated by auxiliary ventilation system using auxiliary fans and flexible ducts. The split ventilation system adopted in Narwapahar mine is an innovative approach of supplying clean air to all the miners in any working place anytime.

Roof control: With the deepening of mines, strata control from roof and sidewalls pose serious problems. In this regard, underground mines of UCIL are designed with adequate safety parameters. The void created by excavation of orebody is systematically filled with deslimed mill tailings. Depending on the stand-up time of roof / excavations, different support types like grouted roof bolts, steel chalkmats etc are placed in defined patterns. Even in-situ pillars are left in stopes for providing necessary stability to the excavations. Assistance of reputed research institutes like Central Mining Research Institute, National Institute of Rock Mechanics and Ground Control and other educational institutions are regularly taken for modeling the stress pattern and taking corrective measures. Adequate instrumentation is systematically carried out to record the strata behaviour in different stages of operation. Jaduguda is the first mine in the country to successfully introduce full column grouted type roof bolts which is an innovative way of supporting the immediate roof specially in wide excavations.

Grade control: Uranium being radioactive, grade control techniques in the mines of UCIL are unique and most modern compared to any other metal mines of the country. Hand-held radiometric probes indigenously designed with high level of accuracy are extensively used to demarcate the orebody. Automated bulk ore assaying facilities at the pit-head of each mine provide the quantitative estimation of run-off-mine ore instantaneously. Further improvement in these systems are being conceptualised in the new mines with the introduction of biometrics.

Newer technology: Mines of UCIL have brought in several new innovative technologies in mine development and stoping. In Jaduguda Mine an innovative practice called in-stope leaching was successfully practiced. It is a unique method of recovering uranium implemented first time in the country with in-house expertise. In two worked out shrinkage stopes in two different levels this operation was carried out. Barren ion-exchange solution were sprayed from the top level so that all the broken ore and walls of stope were washed by leach solution. The pregnant solution collected in collection tanks constructed at the mouth of the chute in lower level was being circulated to achieve sufficient concentration of

the uranium. The solution containing dissolved uranium was being treated in the ion-exchange columns to recover uranium. The entire operation has been carried out successfully recovering a substantial amount of uranium at a very low cost.

Narwapahar is the first mine in the country to successfully adopt a newer method of stoping called Step mining. The method allows movement of large trackless equipment inside the working stope facilitating complete mechanization of all the mining activities. Based on the success of this method, conventional stoping practices have also been upgraded.

The technology of shaft sinking adopted at Narwapahar mine has recorded the highest progess of simultaneous sinking and lining.

In addition, there are several other areas like ventilation, roof control, blasting, stowing where conventional practices have undergone sea changes adopting contemporary technologies.

Safety and monitoring practices: Every day-to-day operation in UCIL mines are planned and executed with utmost care to eliminate and minimise hazards associated with it. Statutory rules and regulations are strictly adhered to with regular monitoring. The uranium ore generally contains all radio-isotopes present in its decay series and these may assume significance at various stages of operations. The mining personnel are therefore, provided with passive personal dosimeters to evaluate individual doses due to exposure to alpha and gamma radiation. In addition, modern personal protective equipment such as respirators, ear-muffs, safety goggles, gumboots, safety helmet etc for protection against injuries and harmful exposures are also provided to mine personnel. Many engineering control measures have been adopted to reduce the noise levels of different heavy machinery in use in underground. Routine monitoring of noise level, air quality, radiation & radioactivity levels like external gamma radiation, airborne radioactivity, surface contamination, radiation dosimetry etc are carried out using sophisticated instruments.

Milling of uranium ore: The conventional way of processing of uranium ore is through hydro-metallurgical route.

Existing plant - Ore from existing three mines of UCIL are processed in a central plant located at Jaduguda. This plant is in operation since 1967 and has been upgraded twice with in-house expertise.

New plants – As UCIL proposes to open new mines in different parts of the country, plants are also planned to treat the mined out ore at suitable locations. The new processing facilities being planned are as follows.

a) A plant of 3000 tonnes per day processing capacity at Turamdih in the district of Singhbhum East, Jharkhand – Construction work for this plant has already started.
b) A plant of 1250 tonnes per day processing capacity in Nalgonda district, Andhra Pradesh.
c) A plant of 1370 tonnes per day processing capacity (275 days in a year) in West Khasi Hills district, Meghalaya .

Plant construction and operation: The uranium processing know-how followed at Jaduguda has been indigenously developed and successfully upgraded time-to-time keeping in pace with the scientific and technological developments taken place in uranium technology. This plant has already undergone two-phase expansion nearly doubling the processing capacity. Many new machineries and state-of-the-art monitoring systems have been introduced with utmost consideration on maximising the recovery, minimising the discharge of effluents and maximising the recovery of by-products.

The new process plants proposed at different sites by UCIL shall adopt further improved systems taking into account many modern concepts with due consideration to –

a) Vast experience of plant operation at Jaduguda
b) Inputs of various laboratory and pilot plant studies on ore samples conducted in-house and in selected laboratories of the country. Some of the tests are still under progress.
c) Information and data available on several modern operations of overseas countries.

Flowsheet design: Uranium is generally extracted through hydro-metallurgical route in one of the two ways – acid leaching or alkali leaching depending on the ore characteristics. UCIL's plant at Jaduguda follows the acid leaching practice. The R&D set-up available in the plant complex at Jaduguda plays a vital role in laboratory studies of the specimen to derive various process parameters. Subsequently, further studies are carried out in pilot plant scale to finalise the parameters. In this regard, a new set-up has been created within Jaduguda mill complex with provisions of all relevant process routes for uranium. The unit

has been named as Technology Demonstration Pilot Plant. Flowsheet of new plants are under development in this unit.

Processing: The uranium ore processing plant at Jaduguda is the first and only one of its kind in the country to treat the uranium ore. It is a hydro-metallurgical plant following the acid leaching method. The plant is fed with the ore produced from Jaduguda, Bhatin and Narwapahar mines. The ore of different sizes undergo crushing followed by two stages of wet grinding. The ground ore in the form of slurry is thickened and leached in leaching pachucas under controlled Ph and temperature conditions. The leached liquor is then filtered and undergo ion-exchange in which uranyl ions get absorbed in the resin. This is further eluted and treated with magnesia to get magnesium di-uranate or yellow cake which is thickened, washed, filtered, dried and packed in drums. The final product of UCIL plant is the Yellow-cake (magnesium di-uranate) which is sent to Nuclear Fuel Complex, Hyderabad for further processing to nuclear grade fuel**.**

The plant at Jaduguda is unique in design to maximize the re-use of water, high recovery of the product and minimum discharge of effluents.

However, some changes in processing concepts are being contemplated in new mills to be constructed soon. Following the ion-exchange, implementation of sulphate elution in place of chloride elution is being preferred as this ensures maximum re-circulation of barren liquor, thereby reducing the requirement of total fresh water and minimizing the discharge of liquid effluent. It is also being considered to implement precipitation of uranium peroxide (UO_4, H_2O) with hydrogen peroxide in place of magnesium di-uranate for prevention of co-precipitation of other metals. This ensures highest purity in product and less environment related problems.

Equipment: Selection and sizing of proper equipment at Jaduguda plant is the key to its success. In this regard, major up-gradations were undertaken during the second phase of expansion of the plant. While selecting the vital equipment due attention has been paid to the adaptability of these equipment to proven technology and compatibility with the balance instrumentation and control systems. Adequate provisions have also been made ensuring flexibility to allow for alternative processing strategies to accommodate unexpected ore characteristics variations. The plant now houses new equipment like steep inclined conveyor, hi-rate thickener, horizontal belt filter and spray drier. A new dust extraction system has been installed in the ore crushing plant. In the fine ore handling section, dry fog system has also been adopted successfully for dust suppression. A new ventilation system is in practice in the chemical house covering filtration, extraction and precipitation units.

In the proposed plants applicability of many new systems like particle size monitoring (PSM) equipment in the grinding circuit, high rate thickener for thickening, belt filter in dewatering and filtration and mechanically agitated leaching tanks etc are being evaluated.

Instrumentation and process control: Jaduguda plant was originally designed with most of manual control systems. However, over the years many automations have been introduced in the plant. Installation of PLC based control system for ion exchange for sequential control of Saunders valves and DCS based on-line control system for control monitoring of PH in leaching pachucas, precipitation tanks and tailings plant have brought in great improvement in metal recovery. XRF based on line analyzer has also been introduced for monitoring of uranium content in ion exchange. Recently closed circuit TV camera has been installed in the plant for monitoring the discharge of ore from various feeders and screens.

The new processing units are being envisaged to encompass a very high degree of instrumentation at all operating corners minimising human interference. PLC based control system shall be based on Man Machine Interface (MMI) with remote input - output and shall have facility to monitor process parameters, status of drives, control of relevant process variables and operate any equipment from plant graphics on operators' station. Local operation facility has been envisaged for all equipment under local operation condition. Closed circuit TV camera will be located in different sections for monitoring of relevant areas from central control room.

Effluent treatment: The treatment of entire effluent generated during the mining and milling is the hallmark of operation at Jaduguda. A modern effluent treatment plant has been set up with the state-of-the-art facilities adjacent to the main processing unit. During the process of uranium extraction from ore, two types of wastes – liquid and solids depleted in uranium- are generated. Though the coarser fraction after neutralization is used as the back-fill material in mines, the fine fraction in the form slurry is pumped to tailings pond. In the tailings pond, the slime settles and the decanted liquid is sent to the effluent treatment plant for removal of some detrimental elements like radium and manganese. This water is first clarified and part of it is sent to plant for re-use. The remaining part is treated with barium chloride for precipitation of radium. Further manganese is precipitated by adding lime for neutralization. The clear liquid after stringent monitoring is released to environment.

Further improvement like containment of clarified liquid in evaporation pond is suggested in new processing plants. A benchmark for zero discharge has been fixed in the new process plants and all efforts are in progress in this direction.

By-product recovery: The plant at Jaduguda contains all facilities to recover the valuable materials as by-products present in the uranium ore. The uranium ore of Jaduguda and Bhatin mine contain recoverable quantity of copper, nickel, molybdenum and magnetite. The flowsheet adopted at Jaduguda plant takes care of recovery of copper, nickel and molybdenum by froth floatation process and magnetite is recovered towards the end as the tailings pass through magnetic separators. The magnetite thus produced is of very high quality in terms of magnetic content and fineness. These magnetites are highly in demand for use in coal washeries. The by-product recovery plant for copper-nickel-molybdenum has now been closed at Jaduguda because of fall in grade of these metals in the ore of new mines.

Uranium recovery from copper tailings: The facility of uranium ore processing at Jaduguda has the unique distinction of recovering uranium from the copper ores containing negligible quantity of uranium. The copper ore of Singhbhum being mined in the vicinity of Jaduguda contain traces of uranium. After recovery of copper, the materials were being disposed as tailings by the copper mine operators. UCIL had established three plants near such copper mines to up-grade the content of uranium in the copper tailings by physical beneficiation (tabling) and processing the same concentrates in the plant at Jaduguda. An appreciable quantity of uranium has been recovered in this process. However, with the closure of near-by copper mines during the last few years, the above concentrate recovery plants have been discontinued by UCIL.

Safety and monitoring practices- Adequate care are taken to ensure safe working practices at each stage of plant operation. Each worker in Jaduguda plant is provided with respirator and other personal protective equipment. Sources of noise are isolated as far as possible. Rubber aprons, gloves, helmets and gumboots are used by persons handling toxic materials and final product. The generation of dust (both radioactive & siliceous) is controlled at source using dust extractor. Local exhausts are provided at dust generation points. Exhaust stream is passed through a scrubber with water spray system. Air activity is controlled by providing fabric dampers to outlets of pipes discharging active solutions to reaction tanks and by covering the tank openings. Final product drums are covered with

thick fabric chute while transferring dry material. Natural ventilation is supplemented by providing series of fans at strategic points.

Monitoring of external gamma radiation, airborne radioactivity, surface contamination, radiation dosimetry, silica dust and noise level etc are carried out at all working places with different modern instruments and techniques.

Disposal of tailings: After extraction of uranium from the ore, the management of waste products – called tailings - has been given utmost importance, since these products contain some radio-nuclides and need to be stored in a proper facility. The tailings management facility established near UCIL's plant at Jaduguda is a well-designed arrangement spread over an area of 194 acres constructed in three phases.

Philosophy- During the processing of uranium ore, some radio-nuclides are generated and remain in the tailings. It is also not possible to recover entire uranium from the ore. A very little amount of uranium always goes with the tailings. Some reagents added during the process of extraction create some chemical toxins and remain within the tailings. Therefore, it is necessary to make a sound impoundment arrangement of storing these material on surface so that they do not contaminate / pollute the environment. The design philosophy adopted in the tailings pond at Jaduguda is adequate in this regard.

Design – While designing the tailings pond adequate measures have been taken to store the tailings for a very long period of time. The pond is located at a safe distance from the population to avoid any direct contamination. The site has natural high hills on all three sides. The embankment constructed in the fourth side is designed to take the load of entire quantity of ore available in the deposits. The material used in construction of embankment consists of impervious clay towards the upstream, random fill material on the downstream side and toe of rock-fill material. At each stage of the dam construction, site studies are conducted to ensure proper strength, slope and height determining the stability. Quality control tests are carried out to ensure the quality of the work as well as construction materials. The permanent drains have been constructed on all sides so as to prevent the flow of rain water into the pond. The decantation wells are strategically placed at the inner periphery of the pond allowing the excess water only to flow out. This water is carried to the effluent treatment plant for necessary processing through a well-laid drainage system. Encroachment into the tailings pond area is prohibited by erection of permanent fences all around. Security personnel are also posted at site as guard against any entry. Large part of the pond is covered with vegetation to prohibit re-suspension of dust into the atmosphere.

Typha latifoliea, *ipomiea carniea*, wild grasses like *cynodon dectylon* etc. are some of the special varieties grown on the surface of the pond.

The technology of tailings pond design and construction has undergone sea changes during last twenty years. In the new processing sites, UCIL proposes to adopt several new technologies like laying of an artificial impermeable layer on the surface of the pond to avoid excursion of effluent into the ground water. A newer method called thickened tailings disposal system is also being contemplated.

Safety and monitoring practices – The safety of the tailings pond is periodically ensured with several site-specific studies involving consultants. During rainy season, adequate measures are taken in cleaning of drains and stabilizing the decantation wells. Routine monitoring of Rn-222 and its progeny is carried out around the tailings pond area using low level radon detection system (LLRDS) and alpha guard. Gamma exposure level is also monitored using scintillometer and micro R survey meter. In order to ascertain the characteristics of migrating radio-nuclides and chemical toxins, monitoring wells are placed around the pond. Water samples from these wells are regularly collected and analysed. Analysis of vegetation grown inside the tailings pond is carried out on regular basis to evaluate the migration of radio-nuclides and chemical additives from tailings pile to vegetation. Near-by population are also provided with dosimeters for detection of radiation dose, if any. The water from different streams and local river system, sediments from river beds are also analysed in different seasons. Samples of soil, grass, vegetables, food-stuff and aquatic organisms like algae, fish etc are collected and analysed. The samples of ground water from wells and hand pumps are periodically collected and analysed for evaluation of radioactive and chemical pollutants.

These surveillances in the area have not shown any significant rise of any harmful elements in the atmosphere in the entire history of UCIL's operations.

Conclusion: Uranium corporation of India ltd. during its 36 years of operation has adopted many new technologies in mining and processing fields and such technologies are comparable with the best practices available anywhere in the world. The corporation has many distinctions of being the first in the country to adopt such technologies.

Recently, the corporation has successfully obtained ISO-9002 certification for its excellent work practices followed at different operating units. It is also the first mining organization

in the country to obtain ISO-14001 certification for the excellent environmental monitoring practices stringently followed in all its working units.

The corporation is also always acclaimed amongst the local people for its multitudinous welfare activities undertaken specially towards the up-liftment of tribals. It has shown utmost concern for the employment, education, health care, infrastructure development, promotion of sports, cultural programme etc amongst the local people.

Tomorrow's UCIL is poised for a massive growth with technological and scientific excellence aspiring to progressively achieve the capability of meeting the entire fuel requirement for the targeted generation of nuclear power. As the corporation marches ahead with its noble endeavor, all efforts are made to accomplish a greater all-round socio-economic development around all its operating units.

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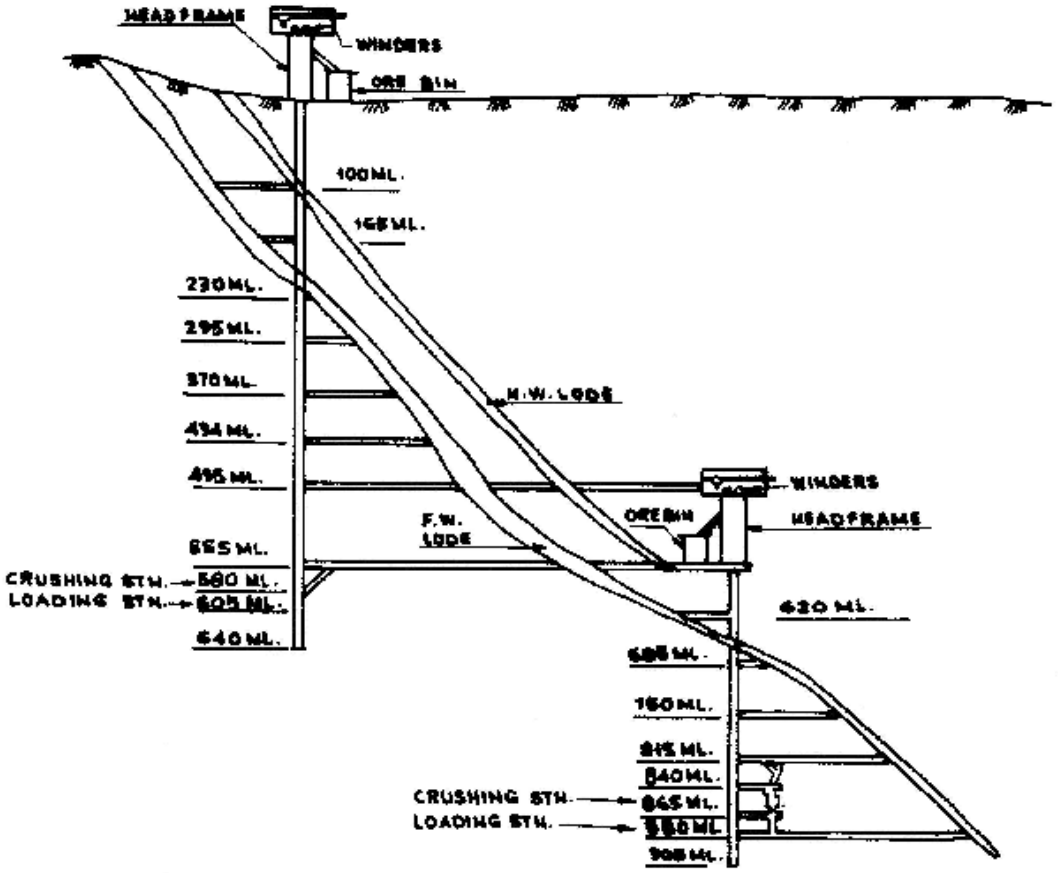
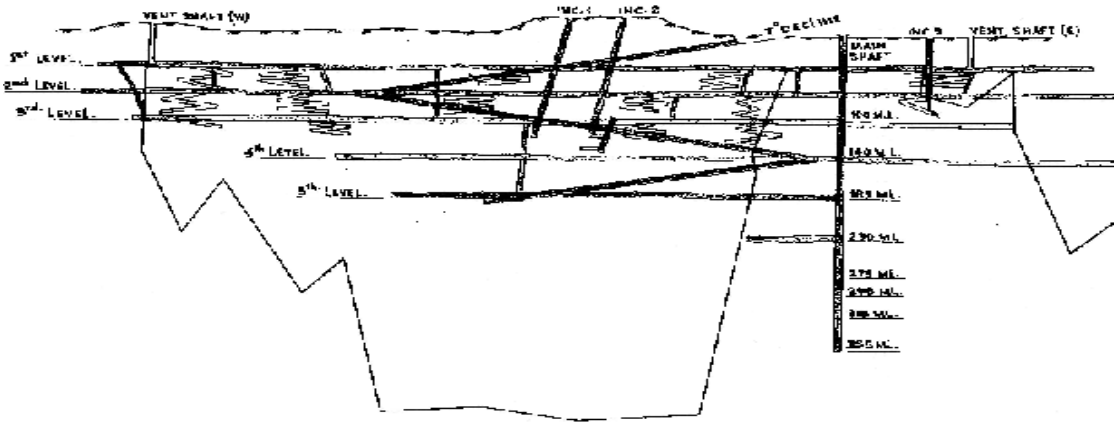


Transverse section

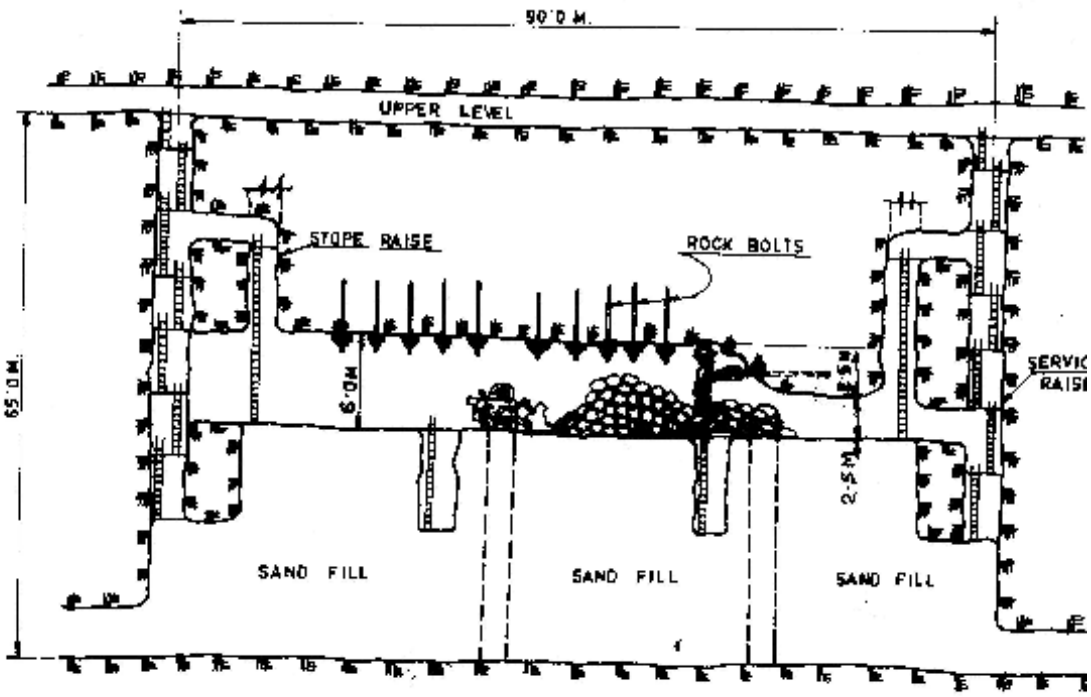
Not to scale

Fig. 1 General layout of Jaduguda Mine

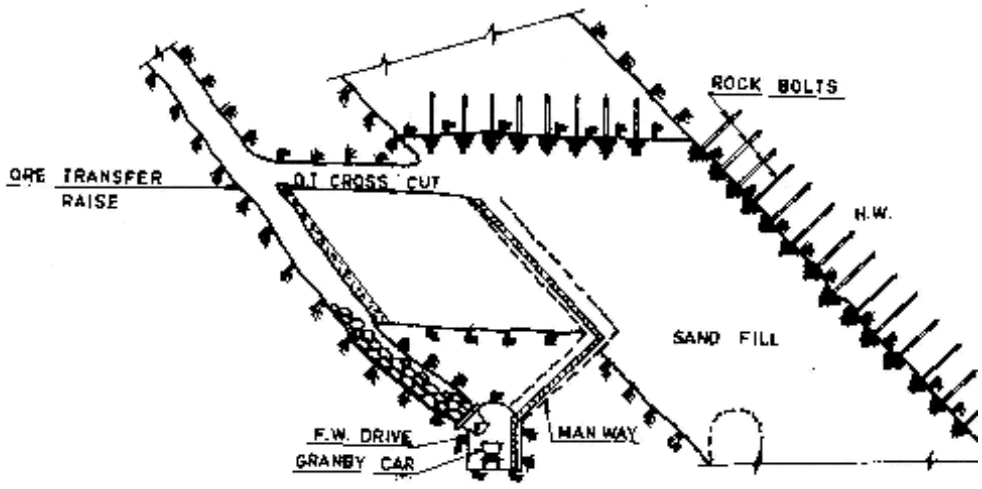


Longitudinal section

Fig. 2 General layout of Narwapahar Mine



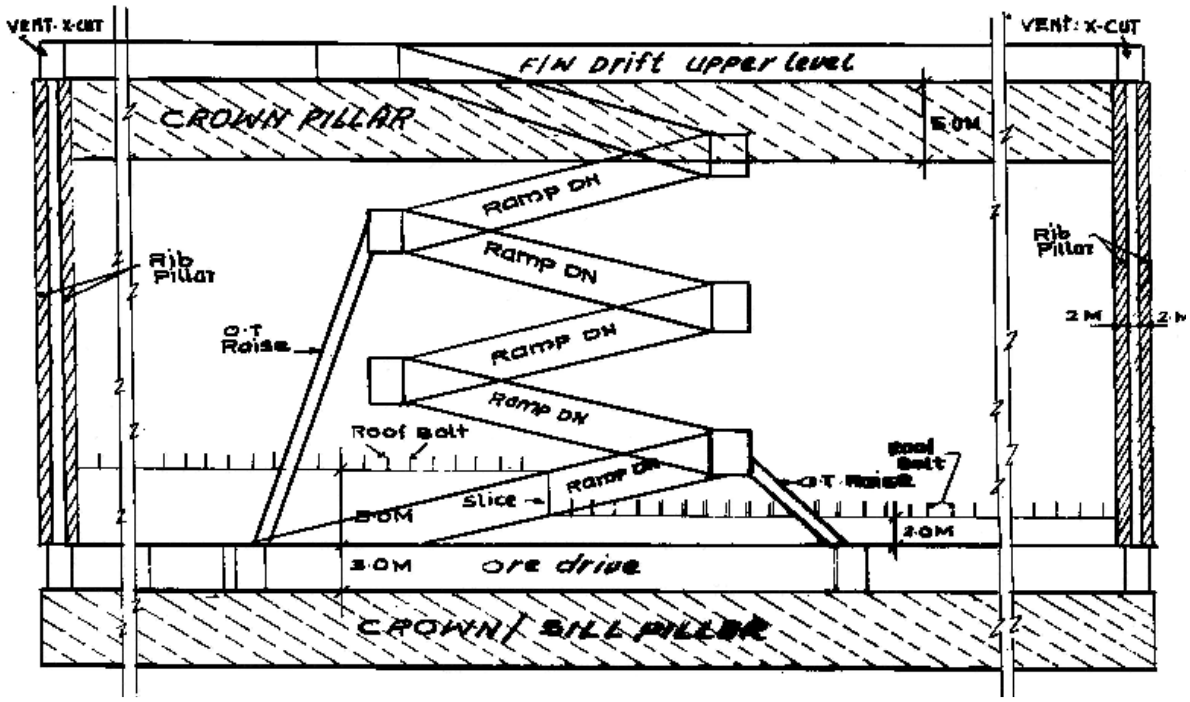
Longitudinal section



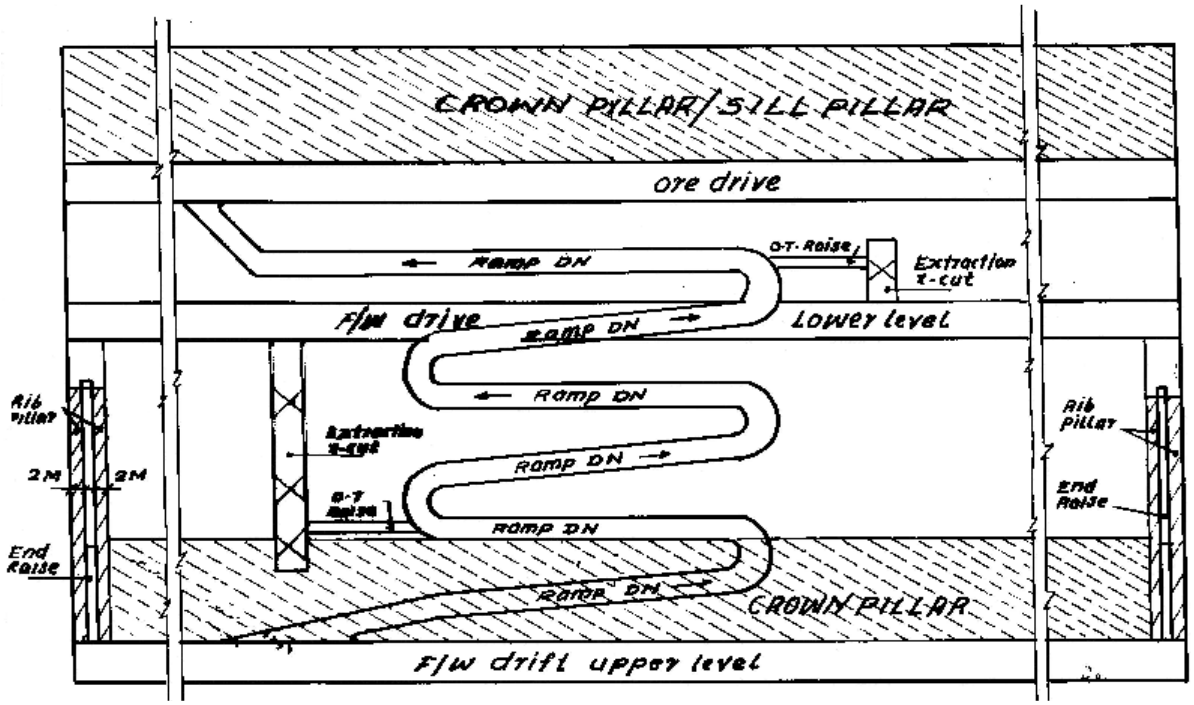
Transverse section

Not to scale

Fig. 3 **General layout of cut-and-fill stope of Jaduguda Mine**



Longitudinal section



Plan

Fig. 4 **General layout of cut-and-fill stope of Narwapahar mine**

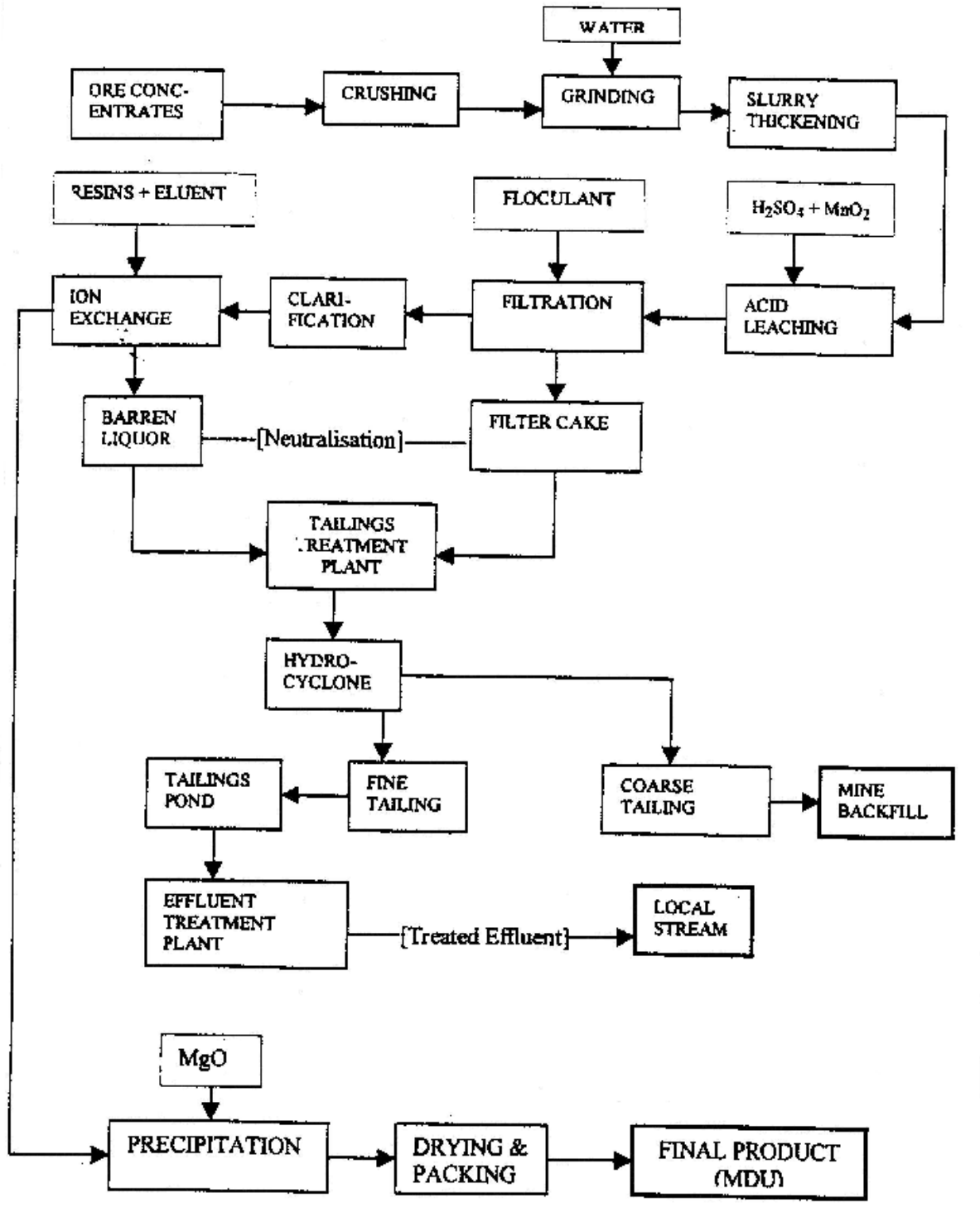


Fig. 5 **Flowsheet of Jaduguda uranium ore processing plant**

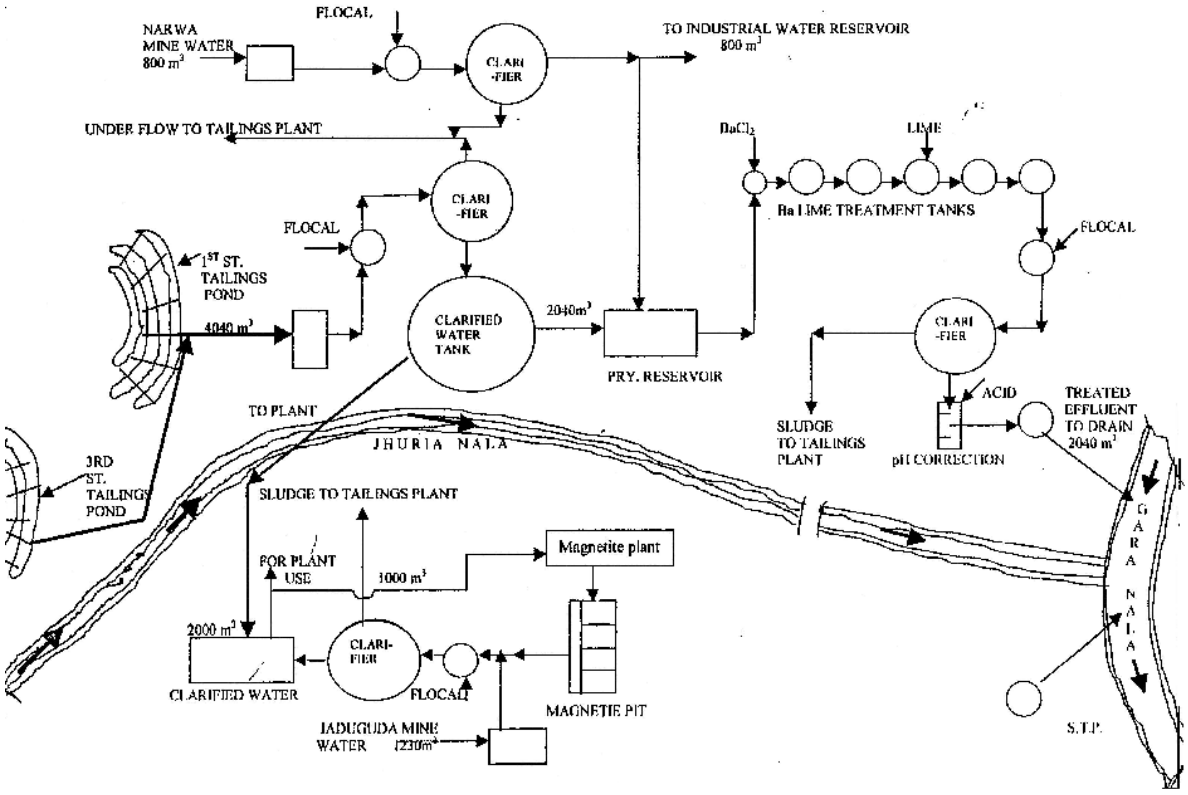
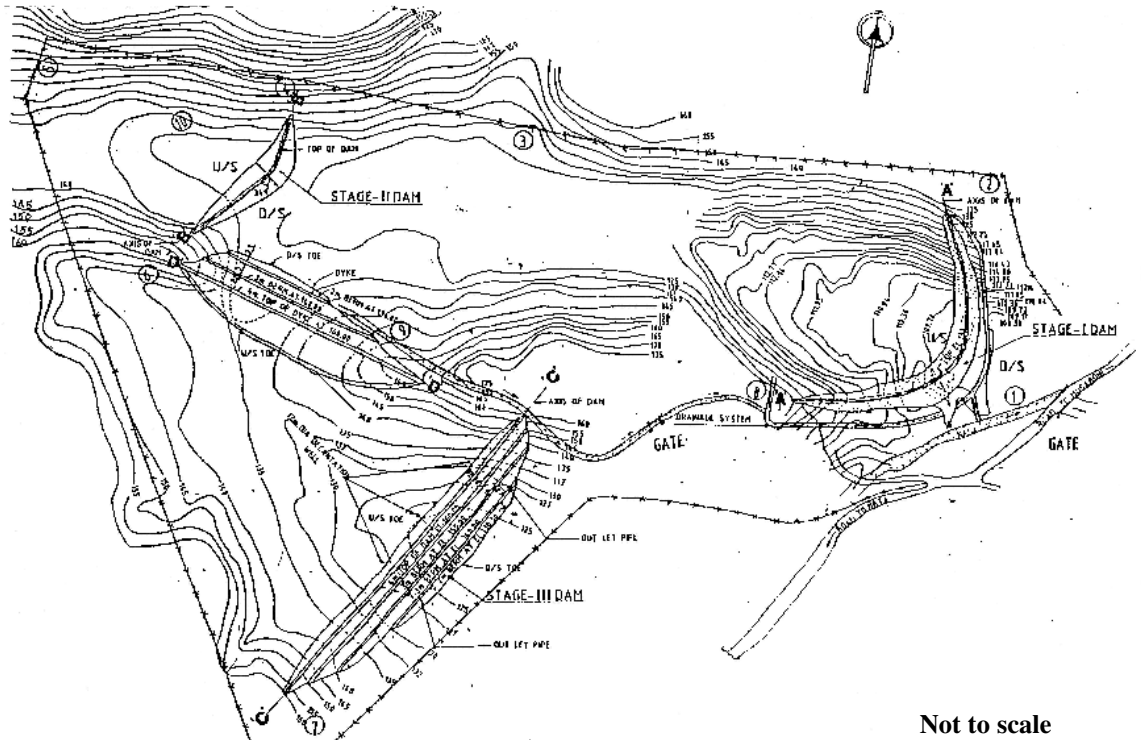


Fig. 6 Flowsheet of Jaduguda effluent treatment plant



Not to scale

Fig. 7. Layout of Jaduguda tailings pond