Golder Associates Ltd.
CONSULTING ENGINEERS

REPORT TO

CAMECO - A CANADIAN MINING & ENERGY CORPORATION

COMPLETION REPORT
BLUFFS STABILIZATION DEMONSTRATION
SECTIONS B5 AND B13
LAKE ONTARIO BLUFFS AREA
PORT GRANBY WASTE MANAGEMENT FACILITY
PORT GRANBY, ONTARIO

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SUMMARY

Sections B5 and B13 of the Lake Ontario Bluffs Area within the Port Granby Waste Management Facility were stabilized during the summer and fall of 1989. This work was carried out to demonstrate the feasibility of the proposed construction and stabilization methods outlined in the report: "Port Granby Decommissioning: Preliminary Engineering Designs for Interim Stabilization".

The remedial works carried out consisted of:

1) Temporarily lowering the groundwater level above the Middle Till by means of an eductor well point dewatering system;

2) Removing the erosion induced loosened soil mass and preparing a suitable working grade;

3) Installing engineered seepage collection and erosion control systems; and

4) Dismantling of the eductor well system, thereby allowing the groundwater level to return to its original conditions.

The construction was carried out from a working platform on the beach area. Excavation of the site above the Middle Till was carried out using a small backhoe lifted to the working level and tethered in position by a 23 tonne crane. The crane was also used to transport filter sand, sand and gravel and rockfill to the working area.

Seepage from the silt stratum above the Middle Till (which had been responsible for the erosion along the Bluffs) is now intercepted by the sand filter/blanket and carried in drainage pipes to a catch basin. It then flows by gravity in a pipe to the East Reservoir.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF PHOTOGRAPHS

LIST OF FIGURES

1.0 INTRODUCTION

This report describes the construction activities and as-built conditions in Sections B5 and B13 of the Lake Ontario Bluffs Area of the Port Granby Waste Management Facility. This work was carried out between May 30 and September 26, 1989.

1.1 General Background

The Port Granby Waste Management Facility is a chemical and low-level radioactive waste management site operated by Cameco - A Canadian Mining & Energy Corporation (hereafter referred to as Cameco). The location of the facility is shown on Figure 1.

Planning for the decommissioning of the Port Granby Waste Management Facility (in response to a directive from the AECB) began in 1980. Significant progress was made in achieving this goal prior to the decision by the Federal Government (October 10, 1986) to assume the responsibility for siting a long-term low-level radioactive waste management facility, and to appoint a Siting Task Force to identify a process for selecting one or more long-term management facilities. This decision redirected Cameco's efforts, on this project, from decommissioning to maintaining the environmental integrity of the site until decommissioning can proceed.

The selection of long-term low-level radioactive waste management sites is a complex and time consuming process. Consequently, in planning for decommissioning of the Port Granby Waste Management Facility, consideration has been given to measures which will ensure that public health and environmental safety are protected during the site selection process and during decommissioning. To this end, a report entitled, "Port Granby Decommissioning: Preliminary Engineering Designs for Interim Stabilization" was prepared in 1988 (Reference 1).

Compatibility with the site's decommissioning is a key element of the "Interim Stabilization Plan". The design serves as a foundation for a more detailed plan should additional stabilization be required prior to decommissioning. The degree to which the designs are ultimately implemented is dependent on the length of time until the site is decommissioned and the interim actual conditions of the site.

Erosion activity of Section B5 of the Lake Ontario Bluffs Area of the Port Granby Waste Management Facility (see Figure 2) has increased over the last two years. During the Geotechnical Inspection of May 2, 1988, small tension cracks were found in the surficial soils at a point 14m from the Upper Fence Line along Section B5. Because these cracks were located within 15m of the fenceline [the trigger point criterion specified in the Monitoring and Response Plan (Reference 2) for the Port Granby Facility], AECB staff requested that this situation be reviewed. Golder Associates was retained to assess the site conditions and evaluate the need for remedial work. It was concluded that any remedial action at Section B5 should be addressed within the context of the "Interim Stabilization Plan". The work described in this report was undertaken as a demonstration study to establish the effectiveness and construction feasibility of the stabilization measures outlined in the "Interim Stabilization Plan".

1.2 Geotechnical Background

The following sections provide a summary of the subsoil and groundwater conditions at the location of Sections B5 and B13 and summarize the predominant mechanism considered to be responsible for the on-going erosion of the Bluffs. Details of the subsurface conditions and the erosion mechanism have been provided in previous reports (Reference 4, 5 and 6). All elevations referred to in this report are relative to mean sea level.

1.2.1 Subsurface Conditions

The subsurface conditions at Section B5, and along the Bluffs in general, consist of a sequence of sands and silts overlying a thin till stratum which, in turn, overlies another sequence of sands and silts over till which is underlain by bedrock. For this project the upper sequence of sands and silts over till is of interest.

The upper 3 m of soil at Section B5 consist of a sand unit. The material in this stratum is in a dense to very dense state of packing. The sand is dry; no seepage is evident from this unit at the bluff face. A piezometer installed at the bottom of the sand stratum in Borehole 504, adjacent to Section B5, has consistently been dry when read.

A silt deposit underlies the upper sands, extending from about Elevation 100 m to about Elevation 86 m. This unit comprises the major stratum outcropping on the Bluffs. The silt stratum is not uniform as it contains relatively pervious zones of sandy silt and relatively impervious zones of clayey silt. The silt stratum is in a very dense state of packing. Piezometers installed in this unit indicate that the groundwater table is at about Elevation 91 m, or about 5 m above the upper surface of the underlying till deposit. The elevation of the groundwater table, as measured in piezometer installations, has been consistent with the corresponding elevation of seepage zones observed at the bluff face.

A till deposit referred to as the Middle Till underlies the thick silt stratum. The Middle Till is between 3 m and 5 m thick. Available information indicates that at Section B5 the contact between the silt stratum and the Middle Till dips downward towards the north. The upper part of the Middle Till unit consists of low permeability clayey silt till which grades into a coarser, more permeable, sandy silt to silty sand till with depth. The competence of the Middle Till is evidenced by a pronounced steeper slope profile at about Elevation 87 m at Section B5.

1.2.2 Erosion Mechanism

The predominant erosion mechanism at Section B5 has been discussed in previous reports and its progress has been monitored for several years during the semi-annual geotechnical site inspections (e.g. Reference 5 and 6). Briefly, the observed erosion is the result of concentrated seepage near the base of the silt stratum. Seepage is concentrated at the silt/Middle Till contact because the relatively impervious Middle Till unit retards the vertical passage of groundwater. Thus, above this contact, groundwater preferentially flows horizontally and emerges at the slope face as seepage. The seepage washes out silt particles from the slope resulting in local steepening and undercutting of the slope above the seepage zone and flattening of the slope in the soft "mud flow" region below the seepage zone. Oversteepening and undercutting continue until a slump occurs which ruptures the overlying root mat and creates a fresh erosion scar. After the slump, the slide debris is carried away in the "mud flow", and the process repeats itself. A properly filtered drainage system will halt this mechanism of erosion by preventing the movement of silt particles as the groundwater seepage emerges from the silt stratum.

1.3 Stabilization Measures

The stabilization undertaken in 1989 comprised 4 main components:

- installation and operation of an eductor dewatering system to temporarily lower the water table,
- excavation of the mudslide debris and loosened soil, and preparation of a suitable subgrade;
- reconstruction of the slope, incorporating a filter/ drainage system; and
- removal of the eductor system on completion of the stabilization work;

These components are addressed individually in the following sections of the report.

2.0 EDUCTOR DEWATERING SYSTEM

A conventional construction eductor dewatering system was installed at Sections B5 and B13 to lower the water table in the silt stratum above the Middle Till layer. This was necessary to permit the safe removal of the mud flow and other debris from the areas of active erosion and to permit the safe construction of the filter/drainage system.

The feasibility of using eductors was established by the August, 1988 Eductor Dewatering Trial carried out by Griffin Groundwater Control Services of Canada Limited under the direction of Golder Associates Ltd. The results of the trial and recommendations for the dewatering system required for the Section B5 and B13 Demonstration are contained in Golder Associates Report 881-1533A (Reference 3).

2.1 Installation of the Eductor System

The eductor system comprised 25 eductor well-points, approximately 130 m of 150 mm to 200 mm diameter supply and collection header pipes, a settling tank/reservoir and dual water pumps (one on a stand-by/back-up basis).

The locations of the 25 eductor wells used for the Section B5 and B13 Demonstration Project are shown on Figure 2. Twenty-four of these wells were installed during the 1989 construction. Well E6 was installed as part of the 1988 eductor trial (Reference 3) and was originally called 6P5. Photograph 1 is a perspective looking east along the wells from well E2.

Each eductor well-point installation consisted of a 50 mm diameter solid PVC casing with a 720 mm long slotted screen section on the bottom end, a sand filter surrounding the screen and a 32 mm diameter return pipe and suction (venturi) tip. The suction tip (attached to the return pipe) includes a series of gaskets which seal it against the well casing. The eductor wells work on the Bernoulli Principle. Water is pumped under pressure down the annulus between the well casing and the return pipe. The flow is constricted as it passes through the venturi tip which causes a pressure drop resulting in a suction being applied to the screened area of the well. The water pumped into the casing together with the water drawn into the hole by the suction returns to the ground surface via the return pipe.

Water under pressure is supplied to each well by a header pipe connected to the pump. Water returns to the reservoir via a second header pipe. The volume of water drawn from the ground overflows from the reservoir tank; in this case, it was carried in a polyethylene pipe to the East Reservoir.

Eductor wells are normally installed by "jetting" them into the ground using water under high pressure. This method was considered inappropriate for this project because of the potential to aggravate the erosion problem by increasing the water supply to the Bluffs. The eductor wells were installed instead using hollow stem augers. Typically, the hollow stem augers were advanced until 0.3 m to 0.5 m penetration of the Middle Till was achieved. This was determined by observing the rate of advance of the augers and the behaviour of the drill head; the Middle Till is much harder than the overlying silts resulting in a much slower rate of advance and much greater labour by the rig. The auger plug was then removed while maintaining a head of water in the augers and the augers were flushed out to remove loose material. Subsequently, a 150 mm thick layer of No. 50 sand was typically placed in the bottom of the hole followed by well screen and casing installation. A filter pack of No. 50 sand was installed around the well assembly as the augers were removed. The sand filter typically extended 0.6 m above the groundwater table. The wells were backfilled using the auger cuttings. An approximately 300 mm thick bentonite seal was placed within the upper 3 m of the hole.

A 13 mm diameter CPVC piezometer was installed in each auger hole along with the eductor well casing. Typical well casing and piezometer installations are shown on Figure 3. The depths of installation of the key elements of each well are summarized on Table 1. The well installations are shown in profile on Figure 4.

The auger installation method worked very well with the exception of installations E1 and E2 at the west end of the system. The soil in this area is sandier than to the east and difficulty was encountered removing the augers after the desired depth had been reached. Installation E2 was attempted three times using augers before it was successfully installed. During the second attempt the augers could only be removed using two 20 ton jacks and a hydraulic backhoe. Installation E1 was installed using H casing (102 mm inside diameter), and wash boring techniques.

Upon completion of the well installations and connection to the header pipe, the individual wells were developed and the system was flushed to prevent silt from wearing the bearings and impellers of the pumps.

The field work for the well installations was supervised on a full-time basis by Golder Associates personnel. The well and eductor system installations were carried out by Griffin Groundwater Control Services of Canada Limited from Brampton, Ontario.

2.2 Eductor System Operation

The system was brought on line in sections to allow evaluation of the effectiveness of the individual wells. Pumping began June 21, 1989 with seven wells. Remaining wells were brought on line June 22, 1989. Figure 5 shows the effect of the operation of wells E10 to E14 on the monitoring piezometers 6P1, 6P2, 6E1A and 6E2 over the first 7 hours of operation. The water level observations in the piezometers after June 22 are summarized in Table 2.

The eductor system discharge rate was determined by observing the time taken to fill a 18.5 l pail. The discharge from the eductor system varied from 0.04 l/s to 0.22 l/s, but was typically about 0.18 l/s. The measured discharge rates are also shown on Table 3. The variation in discharge is considered to be due to fluxuations in groundwater levels and unsteady flow conditions resulting from water "sloshing" around in the eductor reservoir/settling tank.

Chemical analysis was carried out by Cameco on two samples of the effluent from the eductor system. The results of these tests are shown on Table 4.

The effectiveness of the dewatering can be seen from the declining water levels in piezometers 6P1 and 6P2 located near the crest of the slope. Additional evidence of the lowering of the groundwater table was seen in the areas of active erosion, where the mudflow areas had become drier and consolidated; only one area of seepage from the slope was observed at the beginning of earthwork construction on August 14, 1989. Prior to the dewatering, the eroded areas of Section B5 and B13 had been in a "quick" condition.

During excavation of the eroded areas, the groundwater level at the face of the slope was found to vary between the till surface and about 0.5 m above the till surface. At the west end of the reconstruction, the groundwater level was observed to be locally about 1.5 m above the till surface.

2.3 Decommissioning of the Eductor System

The eductor system was shut down on September 20, 1989, once the effluent from the constructed filter/drainage system was observed to be flowing into the East Reservoir.

The eductor pumps, header pipes, return pipes and tips were removed during October, 1989. Cameco will be installing caps on the wells to preserve them for future use, should adjacent sections of the slope require stabilization.

Griffin Groundwater Control Services reported that, based on their examination of the equipment on removal, substantial pitting and corrosion of the pipes and tips had occurred during operation of the system. Griffin attributed this damage to the high salt content of the groundwater since silt particles were not observed in the return water throughout the operation.

3.0 EXCAVATION

3.1 Methodology

Construction methodology was a major consideration for this project. Machinery access from the top of the slope was blocked by the location of the eductor well system. In addition, the strong vegetation cover at and near the top of the Bluffs was not to be destroyed since it contributes significantly to slope stability and provides surface erosion protection.

The filter/drainage layer was required between about Elevation 85 m and 95 m; about one-third to two-thirds of the way up the Bluffs. Heavy equipment could not be used on the Bluffs because of the potential destabilizing effect large dynamic 'point loads' would have on the slope stability/integrity.

The excavation and earthworks contractor was J. Oliver & Sons Excavating Limited of Port Hope. They successfully completed the work using a small Case 580 tractor-mounted backhoe which was lifted to the working area above the Middle Till and tethered during operation by a 23 tonne crane working from the beach area. A temporary construction access road and working platform were constructed along the beach from the West Reservoir area to provide access to Sections B5 and B13.

Once the trees had been removed from the eroded areas and the access roads were in place, the Case 580 was lifted in two pieces to the middle of the work area on the Middle Till. In places, the mudflow material was found to be sensitive to vibration and water (rain), it being necessary to support the backhoe on a platform of strips of plywood (see Photograph 2).

Excavation proceeded from the middle of the site, "ramping" down toward the east end and casting the waste material downslope from the Middle Till contact. The area from Section 1 (see Figure 2) to the east end was excavated laterally to undisturbed silt and vertically down to the Middle Till. The silt and mud flow material were excavated using a 0.6 m wide bucket (without teeth) which produced a smooth final excavation line. Once the till surface was exposed and cleaned, the outfall trench was dug down the slope and the drain trenches were dug into the very hard Middle Till. Excavation of this material was carried out using a 0.45 m wide toothed bucket (see photographs 3 and 4). The excavation of the outflow trench was carried out using a Caterpillar 225 excavator working from the beach area.

During excavation of the drainage trench, water was observed to seep from the silt between the till surface and about 0.5 m above the till surface in some locations. As the trench excavation progressed, layers and patches of loosened silt were removed and a blanket of concrete sand was immediately placed over the silt, allowing the water to escape but preventing migration of the fine silt particles (see Photograph 3).

Once the excavation and drain installations were completed from Section 1 to the east end of the site, work shifted to the west end of the site, working back toward Section 1 using the following methodology:

- Excavating the mudflow material in lifts and sections along the proposed drainage trench alignment to about 0.5 m above the Middle Till, casting to edge of slope.
- Moving to the south and excavating castings from the above step, recasting over the slope.
- Moving back to the drainage trench alignment and excavating to the final lines, installing the drain and sand drainage blanket on wet areas as the excavation proceeded.
- Moving to the south and excavating cast material from the previous operation, casting over the edge of the slope.

Photographs 5 and 6 illustrate this work at the west end of the site.

Excavation for the filter/drainage layer commenced on August 22, 1989 and was completed by August 31, 1989, with the exception of the excavation for the concrete catch basin installation which was carried out September 11, 1989. Total excavation from the upper bank was about 250 m^3.

The Case 580 backhoe was able to reach all the back slopes except the highest failure scarp area near Survey Point 5-2. This area was cleaned manually by pick and shovel into a concrete bucket and lifted by crane to dump trucks on the beach for stockpilling in the Waste Storage Area within the plateau area of the Facility.

Upon completion of the excavation above the Middle Till surface, the lower portion of the slope was stripped to undisturbed material using the Caterpillar 225 excavator and a 1.2 m^3 ditching bucket (see photographs 7, 8 and 9). The mudflow debris and cast material from the filter/drainage layer installation were loaded into tandem dump trucks and stockpiled in the Waste Storage Area of the Facility.

3.2 Survey Control

Survey control for the project was provided by Golder Associates. The survey was carried out using a Pentax theodolite. Stadia methods were used to determine elevations and locations of features, original ground surface and the excavated ground surface. The survey was carried out relative to the ground surface of Borehole 504 (Elevation 103.60 m).

Work on the slope was controlled from a series of reference points which were established from the top of the Bluffs by stadia methods. Closure of the control survey was 15 mm, which is considered acceptable accuracy.

4.0 SLOPE RECONSTRUCTION

4.1 Seepage Collection

Groundwater, seeping from the silt deposit overlying the Middle Till, is now intercepted by a sand filter layer and flows by gravity into a drainage trench. The constructed drainage trench incorporates a 150 mm diameter perforated Big "O" plastic pipe with filter sock which drains the water from the filter sand and conveys it to the concrete catch basin. From the catch basin, the water flows by gravity through plastic pipe to the East Reservoir. Details of the drainage system can be seen on the as-built cross-sections (Figures 6, 7, 8 and 9) and on the drainage trench profile (Figure 10). Components of the collection system are discussed in detail in the following paragraphs.

The drainage pipes in the east and west trenches slope generally towards the catch basin. The west pipe incorporates a slight dip at about the location of cross-section 2 (see Figure 10) which was due to a layout error. The east pipe has a low spot east of the catch basin which occurred because the catch basin was installed after the drain pipes had been installed. To incorporate a slight dip as shown was considered preferable to completely excavating the east end of the site to re-align the pipe. These dips will not impede the effectiveness of the drain.

The system was originally designed and constructed with one drainage trench extending across the site, and a single 150 mm diameter solid drain pipe to convey the seepage to a sump on the beach. However, during the September 1, 1989 site visit, AECB staff pointed out that it was a licensing requirement to carry out the Bluff Stabilization Demonstration program according to Reference 1. Reference 1 indicated that the seepage would be directed to the East Reservoir, therefore, a catch basin was added to the drainage system and the effluent was directed to the East Reservoir for treatment prior to discharge to Lake Ontario.

The catch basin shown on Figures 2 and 10 was installed on September 11, 1989. The sand and gravel wedge and the filter blanket already installed in this area were removed and the fill was excavated to accommodate a 1.1 m outside diameter precast well-tile "manhole". The concrete base of the catch basin was cast in situ and the individual sections of well tile were set in mortar. The catch basin serves as a collector for the seepage, a settling chamber to catch any silt which may migrate into the drain, and an inspection port for the system. Once the concrete was set, the interior of the sump was water-proofed. The excavation was backfilled with compacted Granular "A" fill to within 0.3 m of the pipe inverts. From that level, a 0.2 m to 0.3 m thickness of sand/bentonite mixture was placed to impede water from seeping through the excavation in the Middle Till to the lower sands.

The water flowing into the sump was observed to be clear during both construction and the November, 1989 Geotechnical Inspection of the Facility and, according to Cameco personnel, has remained so to date.

The drain pipe trenches were backfilled with concrete sand except in the vicinity of Section 1 (Figure 2) where Granular "A" was used. The outfall trench was filled with compacted till material near the crest of the slope to prevent water from the trench from draining down the outfall trench. The remainder of the trench was backfilled with Granular "A" to within 1.0 m of the surface and then with rockfill to the surface of the slope.

A piezometer tip was installed to Elevation 86.09 m at the location shown on Figure 2 adjacent to the west drain pipe. On September 21, 1989, the water level in this piezometer was at Elevation 86.19 m.

The catch basin was constructed with three effluent pipe openings (see Figure 10). A 100 mm diameter SDR (standard dimension ratio) 35 PVC sewer pipe was installed from the catch basin to the face of the slope, east of Section B-13. The purpose of this pipe is to provide a large diameter effluent route should westward extensions of the drainage system develop flows which exceed the present capacity. This pipe is capped at both ends.

A 100 mm diameter ABS pipe was connected into the catch basin approximately 0.2 m above the outfall invert to serve as an emergency overflow, should the existing flow capacity of the outfall line to the East Reservoir be exceeded.

The outflow line (for normal anticipated flows) is a 50 mm diameter polyethylene pipe. This pipe runs independently from the catch basin for about 1 m where it, together with the 100 mm ABS overflow pipe, enters the solid 150 mm diameter outfall pipe which had originally been installed to carry the water from the drainage pipes to the beach sump. The overflow discharges into the 150 mm diameter pipe and the 50 mm diameter outfall line continues inside the pipe to the beach. The 50 mm pipe exits the 150 mm pipe in the sump at the base of the Bluffs and travels underground at a depth of about 1.2 m along the beach to a point opposite the East Reservoir. It then goes up from the beach, through the gate in the perimeter fence to a vent at a high point marked by a 100 mm x 100 mm wooden post adjacent to the East Reservoir power box. Finally, it flows down to the East Reservoir in a heat-traced section of polyethylene pipe.

Concentrated seepage was observed to be flowing from the front of the Bluffs in the area west of Section B5. To prevent this seepage from undercutting the stabilization work where it blends into the natural bluffs, a small piece of 100 mm diameter perforated Big "O" pipe with filter sock was installed at the location shown on Figure 2 to collect this water. A 100 mm diameter solid pipe conveys this water to the beach; the elevation of the west drain pipe made it impossible to direct this seepage to the catch basin.

4.2 Upper Bank Reconstruction

The elements of upper bank reconstruction were:

1) Placement of a filter layer of concrete sand against the exposed natural silt;
2) Placement of compacted granular "A";
3) Placement of Mirafi P-150 geotextile (filter fabric); and
4) Placement of rockfill.

Items 1 and 2 were placed using a 0.4 m^3 "concrete" bucket on the hook of the 23 tonne crane. By working from locations at either end of the slope, the crane was able to swing these materials to the entire working area. In the vicinity of Survey Point 5-2 (see Figure 2) the crane was working at the limit of its reach. The Granular "A" material was compacted in approximately 0.2 m to 0.3 m lifts using a conventional plate tamper. Photographs 6, 8, 10 and 11 illustrate this phase of the work.

The filter fabric was placed perpendicularly to the crest of the slope with approximately 0.3 m overlap between sheets. Typically three sections (2.5 m wide) were placed at a time. These were covered with rockfill to finished grade before the next three sections were installed (see Photograph 12).

The rockfill was placed using a specially manufactured bucket which also was maneuvered by the 23 tonne crane. With a little practice, two labourers were able to position the bucket and drop the rock in the desired position. Very little hand placement of the rock was required.

The reconstructed slope is shown in section on Figures 3, 6, 7 and 8. The quantities of materials placed are summarized on Table 5.

4.3 Lower Bank Reconstruction

The lower bank, from the Middle Till surface down to the beach was graded to an even slope and protected with erosion protection to prevent potential undercutting of the work completed on the upper bank. The lower 1.5 m portion of the lower bank (comprised of the lower sands) was protected by regrading the rock-fill working platform against the slope. The upper section of the lower bank was covered with about 100 mm of topsoil, seeded and covered with an erosion control blanket (see photographs 13 and 14). The erosion control blanket was C-125 coconut fibre mat manufactured by North America Green. The mat was laid on the slope using the crane, with a 50 mm overlap between adjacent sections after the slope had been seeded.

Grass had begun to grow by October 3, 1989. Once the vegetation is thoroughly established on the lower slope, Sections B5 and B13 should require minimal maintenance. However, in the interim, it may be necessary to replace topsoil and to reseed some areas.

4.4 Performance Evaluation

The remedial works carried out at Section B5 as part of the Bluffs Stabilization Demonstration of the Lake Ontario Bluffs Area of the Port Granby Waste Management Facility and as described in this report, indicate that it is feasible to construct the proposed "Interim Stabilization" measures consisting of an engineered filter/drainage and erosion control system. To date, it appears that the performance will continue to be satisfactory and that erosion and upslope retrogression is halted in the area of

Sections B5 and B13. Further time is expected to provide confidence in the overall performance of the remedial works.

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REFERENCES

1. Report to AECB jointly prepared by Cameco and Golder Associates Ltd. entitled; "Port Granby Decommissioning - Preliminary Engineering Designs for Interim Stabilization", dated December, 1988.

2. Report to Cameco by Golder Associates Ltd. entitled; "Update of 1983 Monitoring and Response Plan, Port Granby Waste Management Facility, Port Granby, Ontario", Report 871-1033, dated July, 1987.

3. Report to Cameco by Golder Associates Ltd. entitled; "Eductor Dewatering Trial - Section B5 - Lake Ontario Bluffs Area, Port Granby Waste Management Facility, Port Granby, Ontario", Report 881-1533A, dated October, 1988.

4. Report to Atomic Energy Control Board prepared by Eldorado Resources Limited entitled; "Port Granby Decommissioning: Conceptual Designs for Interim Stabilization", dated August, 1988.

5. Report to Eldorado Nuclear Limited prepared by James F. MacLaren and Golder Associates entitled; "A Review of Decommissioning Alternatives for the Port Granby Waste Management Area", dated April 24, 1979.

6. Report to Eldorado Resources Limited prepared by Golder Associates entitled; "First Geotechnical Inspection, May, 1988, Port Granby Waste Management Facility, Port Granby, Ontario". Report 871-1179-2, dated June 16, 1988.

TABLE 1

PIEZOMETER AND EDUCTOR WELL INSTALLATION DATA
PORT GRANBY - SECTIONS B-5 AND B13

INSTALLATION NUMBER	GROUND SURFACE ELEVATION (m)	DEPTH OF HOLE (m)	DEPTH TO TILL (m)	DEPTH TO TIP OF PIEZOMETER (m)	DEPTH TO TIP OF EDUCTOR (m)	DEPTH TO TOP OF FILTER PACK (m)	DEPTH TO TOP OF BENT. SEAL (m)
E-1 *	105.01	17.98	17.98	17.80	17.80	11.60	8.53
E-2	104.86	18.30	17.98	16.80	16.80	12.20	3.96
E-3	104.85	18.60	18.10	16.90	18.40	12.20	-
E-4	104.52	18.30	17.70	18.10	18.10	12.20	0.00
E-5	104.46	18.60	17.90	18.20	18.20	12.20	0.91
E-6 **	104.27	18.10	17.80	18.10	18.10	10.70	0.15
E-7	103.84	18.10	17.70	17.98	17.98	11.90	1.50
E-8	103.63	18.40	18.10	18.30	18.30	11.60	1.50
E-9	103.52	18.30	18.00	18.10	18.10	11.90	1.50
E-10	103.49	18.30	18.00	18.10	18.10	11.60	1.50
E-11	103.53	18.60	17.98	18.30	18.30	11.30	0.60
E-12	103.50	18.30	17.98	18.10	18.10	11.60	0.60
E-13	103.43	18.40	17.98	18.30	18.30	11.30	0.90
E-14	103.38	18.60	17.98	18.30	18.30	11.90	1.50
E-15	103.31	18.40	17.98	18.20	18.20	11.90	1.20
E-16	103.18	18.60	18.10	18.30	18.30	11.60	1.50
E-17	103.06	18.90	18.10	18.60	18.60	12.20	1.80
E-18	102.91	18.90	18.10	18.30	18.30	12.20	1.80
E-19	102.88	18.60	18.10	18.40	18.40	12.20	1.20
E-20	102.87	18.10	17.85	18.00	18.00	11.60	1.50
E-21	103.73	18.30	17.83	18.10	18.10	11.30	1.20
E-22	102.47	17.70	17.40	17.10	17.10	12.20	0.90
E-23	102.27	17.20	16.91	17.00	17.00	11.70	1.20
E-24	102.04	17.10	16.80	16.90	16.90	11.90	3.00
E-25	101.81	16.90	16.50	16.70	16.70	12.50	1.50
6E1A	103.50	18.00	17.50	-	***	11.90	0.15
6E2	103.50	17.80	17.50	17.60	***	10.70	0.10
6P1	103.50	16.80	-	16.80	***	13.10	12.30
6P2	103.40	17.50	17.20	17.50	***	12.50	12.30

* All holes except E-1 were drilled with 203mm hollow stem augers 5 1/4" I.D.
E-1 drilled with H casing and washboring techniques.
Eductor well casing and screen 50mm PVC Sch.40.
Piezometers 12.7mm tubing,slotted with hack saw and wrapped in filter cloth.
** E-6 is previous 6P5.
*** Eductors not installed during demonstration study.

TABLE 1

PIEZOMETER AND EDUCTOR WELL INSTALLATION DATA
PORT GRANBY - SECTIONS B-5 AND B13

INSTALLATION NUMBER	GROUND SURFACE ELEVATION (m)	DEPTH OF HOLE (m)	DEPTH TO TILL (m)	DEPTH TO TIP OF PIEZOMETER (m)	DEPTH TO TIP OF EDUCTOR (m)	DEPTH TO TOP OF FILTER PACK (m)	DEPTH TO TOP OF BENT. SEAL (m)
E-1 *	105.01	17.98	17.98	17.80	17.80	11.60	8.53
E-2	104.86	18.30	17.98	16.80	16.80	12.20	3.96
E-3	104.85	18.60	18.10	16.90	18.40	12.20	-
E-4	104.52	18.30	17.70	18.10	18.10	12.20	0.00
E-5	104.46	18.60	17.90	18.20	18.20	12.20	0.91
E-6 **	104.27	18.10	17.80	18.10	18.10	10.70	0.15
E-7	103.84	18.10	17.70	17.98	17.98	11.90	1.50
E-8	103.63	18.40	18.10	18.30	18.30	11.60	1.50
E-9	103.52	18.30	18.00	18.10	18.10	11.90	1.50
E-10	103.49	18.30	18.00	18.10	18.10	11.60	1.50
E-11	103.53	18.60	17.98	18.30	18.30	11.30	0.60
E-12	103.50	18.30	17.98	18.10	18.10	11.60	0.60
E-13	103.43	18.40	17.98	18.30	18.30	11.30	0.90
E-14	103.38	18.60	17.98	18.30	18.30	11.90	1.50
E-15	103.31	18.40	17.98	18.20	18.20	11.90	1.20
E-16	103.18	18.60	18.10	18.30	18.30	11.60	1.50
E-17	103.06	18.90	18.10	18.60	18.60	12.20	1.80
E-18	102.91	18.90	18.10	18.30	18.30	12.20	1.80
E-19	102.88	18.60	18.10	18.40	18.40	12.20	1.20
E-20	102.87	18.10	17.85	18.00	18.00	11.60	1.50
E-21	103.73	18.30	17.83	18.10	18.10	11.30	1.20
E-22	102.47	17.70	17.40	17.10	17.10	12.20	0.90
E-23	102.27	17.20	16.91	17.00	17.00	11.70	1.20
E-24	102.04	17.10	16.80	16.90	16.90	11.90	3.00
E-25	101.81	16.90	16.50	16.70	16.70	12.50	1.50
6E1A	103.50	18.00	17.50	-	***	11.90	0.15
6E2	103.50	17.80	17.50	17.60	***	10.70	0.10
6P1	103.50	16.80	-	16.80	***	13.10	12.30
6P2	103.40	17.50	17.20	17.50	***	12.50	12.30

* All holes except E-1 were drilled with 203mm hollow stem augers 5 1/4" I.D.
E-1 drilled with H casing and washboring techniques.
Eductor well casing and screen 50mm PVC Sch.40.
Piezometers 12.7mm tubing,slotted with hack saw and wrapped in filter cloth.
** E-6 is previous 6P5.
*** Eductors not installed during demonstration study.

TABLE 2

WATER LEVEL OBSERVATIONS
PORT GRANBY - SECTIONS B-5 AND B-13

WELL NUMBER	GROUND SURFACE ELEVATION (m)	DEPTH BELOW G.S ON JULY 4,89 (m)	WATER LEVEL (m)	DEPTH BELOW G.S ON JULY 11,89 (m)	WATER LEVEL (m)	DEPTH BELOW G.S ON JULY 17,89 (m)	WATER LEVEL (m)	DEPTH BELOW G.S ON JULY 27,89 (m)	WATER LEVEL (m)	DEPTH BELOW G.S ON AUG 9,89 (m)	WATER LEVEL (m)	DEPTH BELOW G.S ON AUG 17,89 (m)	WATER LEVEL (m)	DEPTH BELOW G.S ON SEP 6,89 (m)	WATER LEVEL (m)
E-1	105.01	18.02	86.99	18.05	86.96	18.05	86.96	18.07	86.94	18.04	86.97	18.01	87.00	18.05	86.96
E-2	104.86	DRY TO 16.30	88.56	DRY TO 16.32	88.54	DRY TO 16.32	88.54	DRY TO 16.28	88.58	DRY TO 16.32	88.54	16.28	88.58	BLOCKED @4m	-
E-3	104.85	17.62	87.23	17.69	87.16	DRY TO 17.70	87.15	DRY TO 17.70	87.15	DRY TO 17.72	87.13	17.74	87.11	17.03	87.82
E-4	104.52	11.50	93.02	9.33*	95.19	15.77*	88.75	15.60	88.92	15.56	88.96	15.53	88.99	15.86	88.66
E-5	104.46	18.16	86.30	18.15	86.31	DRY TO 18.17	86.29	DRY TO 17.88	86.58	DRY TO 17.88	86.46	DRY TO 17.93	86.56	17.85	86.61
E-6	104.27	18.22	86.05	18.24	86.03	18.23	86.04	18.22	86.05	17.94	86.33	18.02	86.25	DRY TO 18.30	85.97
E-7	103.84	16.18	87.66	16.44	87.40	DRY TO 17.11	86.73	17.67	86.17	17.58	86.26	17.55	86.29	17.65	86.19
E-8	103.63	18.04	85.59	18.05	85.58	18.04	85.59	18.04	85.59	17.88	85.75	16.11	87.52	18.06	85.57
E-9	103.52	17.88	85.64	17.93	85.59	17.87	85.65	17.94	85.58	17.90	85.62	17.80	85.72	17.95	85.57
E-10	103.49	17.96	85.53	18.00	85.49	18.12	85.37	18.02	85.47	17.94	85.55	18.00	85.49	DRY TO 18.02	85.47
E-11	103.53	NOT READ	-	17.85	85.68	17.85	85.68	DRY TO 17.85	85.68	DRY TO 17.88	85.65	17.88	85.65	17.87	85.66
E-12	103.50	17.98	85.52	18.25	85.25	18.33	85.17	18.25	85.25	DRY TO 18.18	85.32	18.20	85.30	18.30	85.20
E-13	103.43	18.10	85.33	18.05	85.38	18.07	85.36	18.11	85.32	DRY TO 18.03	85.43	18.08	85.35	DRY TO 18.26	85.17
E-14	103.38	18.07	85.31	17.90	85.48	18.00	85.38	17.93	85.45	17.88	85.50	17.97	85.41	NOT READ	-
E-15	103.31	18.11	85.20	17.83	85.48	18.07	85.24	18.10	85.21	DRY TO 17.48	85.83	DRY TO 18.20	85.11	NOT READ	-
E-16	103.18	18.12	85.06	18.09	85.09	18.08	85.10	18.11	85.07	18.06	85.12	DRY TO 18.39	84.79	18.05	85.13
E-17	103.06	17.92	85.14	17.10	85.96	17.20	85.86	17.77	85.29	16.45	86.61	DRY TO 18.56	84.50	17.14	85.92
E-18	102.91	18.20	84.71	18.08	84.83	18.09	84.82	18.09	84.82	17.96	84.95	17.10	85.81	BLOCKED @5.5m	-
E-19	102.88	DRY TO 18.56	84.32	18.40	84.48	18.41	84.47	18.38	84.50	18.30	84.58	18.20	84.68	18.38	84.5
E-20	102.87	17.75	85.12	17.99	84.88	DRY TO 18.00	84.87	17.77	85.10	17.64	85.23	17.87	85.00	17.30	85.57
E-21	103.73	9.43	94.30	9.52*	94.21	16.79*	85.94	16.66	87.07	11.56*	91.17	DRY TO 18.05	84.42	BLOCKED @5m	-
E-22	102.47	16.21	86.26	15.78	86.69	16.36	86.11	16.34	86.13	15.50	86.97	16.02	86.45	16.12	86.35
E-23	102.27	17.06	85.21	16.99	85.28	17.00	85.27	17.01	85.26	16.96	85.31	17.00	85.27	17.00	85.27
E-24	102.04	16.77	85.27	17.03	85.01	17.64	84.40	16.98	85.06	16.90	85.14	16.91	85.13	16.95	85.09
E-25	101.81	16.54	85.27	16.41	85.40	15.98	85.83	16.48	85.33	14.98	86.83	15.16	86.65	16.23	85.58
6P1	103.49	15.20	88.29	15.42	88.07	15.54	87.95	15.71	87.78	15.73	87.76	15.58	87.91	15.77	87.72
6P2	103.40	16.08	87.32	16.26	87.14	16.36	87.04	16.38	87.02	16.24	87.16	16.53	86.87	16.50	86.90
6E1A	103.47	16.36	87.11	16.50	86.97	17.71	85.76	16.73	86.74	-	-	16.16	87.31	16.59	86.88
6E2	103.47	17.20	86.27	17.35	86.12	17.42	86.05	17.72	85.75	16.56	86.91	16.99	86.48	16.67	86.80

* Wells disconnected on this date.

TABLE 3

DISCHARGE RATES FROM EDUCTOR SYSTEM

PORT GRANBY - SECTIONS B5 AND B13

DATE	RATE (l/s)
89/06/26	0.04
89/07/04	0.12
89/07/17	0.22
89/07/27	0.21
89/08/14	0.08
89/08/17	0.20
89/08/21	0.20
89/08/22	0.20
89/08/24	0.17
89/08/28	0.17
89/08/30	0.16
89/09/01	0.22
89/09/07	0.16
89/09/08	0.18
89/09/11	0.15
89/09/12	0.17
89/09/13	0.16
89/09/14	0.17
89/09/15	0.16
89/09/18	0.19
89/09/20	0.15

Eductor system started up June 26, 1989.

Eductor system shut down September 20, 1989.

TABLE 4

ANALYTICAL RESULTS OF WATER SAMPLES TAKEN FROM THE DISCHARGE OF THE EDUCTOR WELL DE-WATERING SYSTEM

Sample Date	Radium-226 (Bq/L)	Arsenic (mg/L)	pH	Sulphate (mg/L)	Uranium (mg/L)	Fluoride (mg/L)	Nitrate (mgN/L)	Ammonium (mgN/L)	Chloride (mg/L)
Aug.9/89	0.210	0.08	7.62	2020	1.1	0.20	3100	73	35
Sep.20/89	0.110	0.10	7.47	2000	0.85	0.40	2100	99	33

NOTE: Analytical determination performed by Cameco, Port Hope Laboratory.

TABLE 5

MATERIAL QUANTITIES

ITEM	ORIGINAL ESTIMATE	ASBUILT
Concrete Sand	180 m^3	90 m^3
Granular A	500 m^3	250 m^3
Rock Fill	220 m^3	150 m^3
Total Fill	900 m^3	490 m^3
Access Roads (Rock Fill)	500 m^3	300 m^3
Filter Fabric	675 m^2	750 m^2
Erosion Control Blanket	NA	600 m^2
150 mm Dia. Drainpipe (Solid and Perforated)	65 m	55 m
100 mm Dia. Drainpipe (Solid and Perforated)	NA	17 m

====================

NOTE: Excavation and filter/drain blanket volumes are calculated based on end area calculations using Sections 1 through 4. Access road volumes estimated from tonnages delivered during road building.

PHOTO 1: Eductor Wells and Header Pipes, Looking East from Well E2.

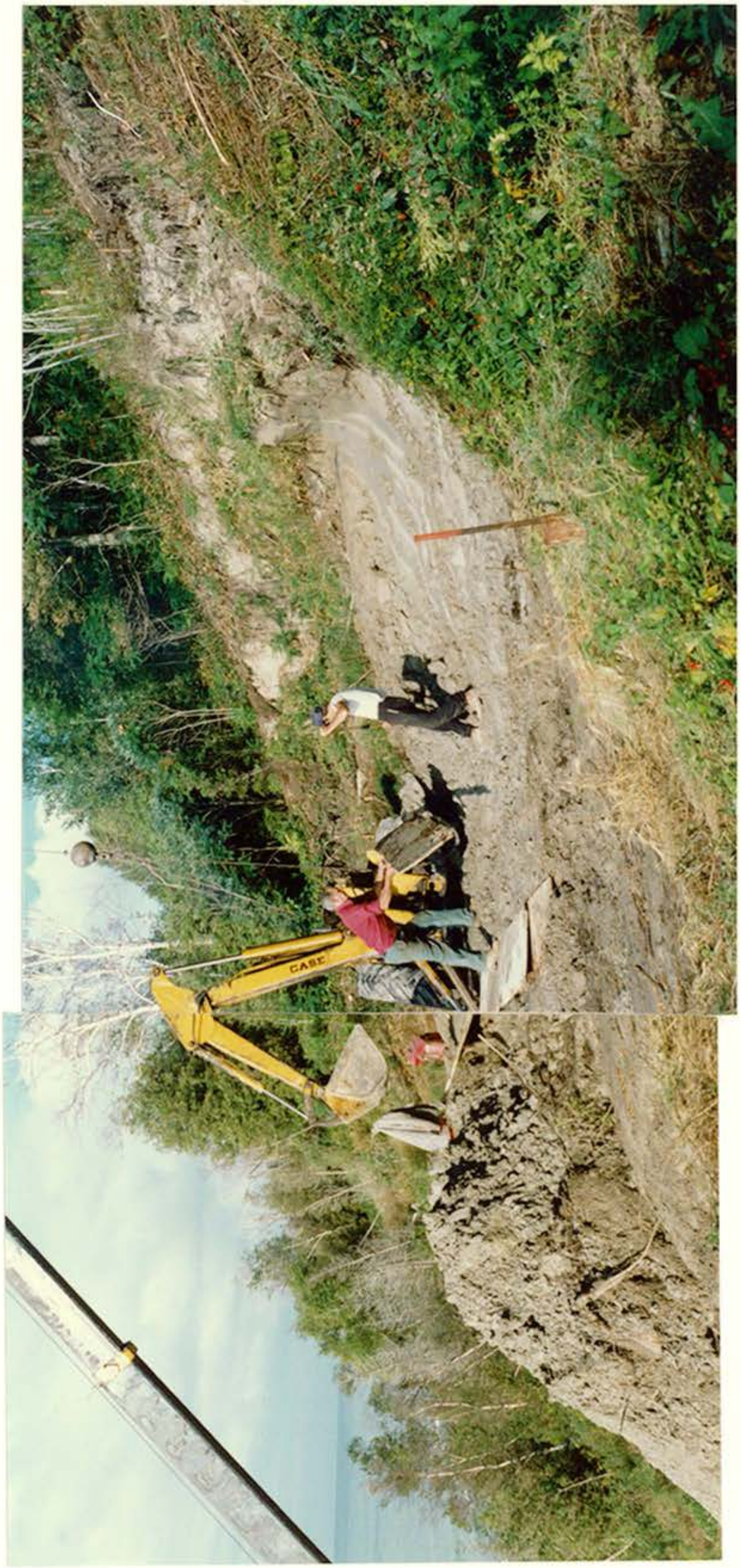


PHOTO 2: Initial Conditions, August 22, 1989.

PHOTO 3: Initial Placement of Sand Filter and Granular "A" Material at East End. Note: part of this area was subsequently re-excavated to install the catch basin.

PHOTO 4: Initial Placement of Sand and Granular "A" Material at East End. Note: part of this area was subsequently re-excavated to install the catch basin.

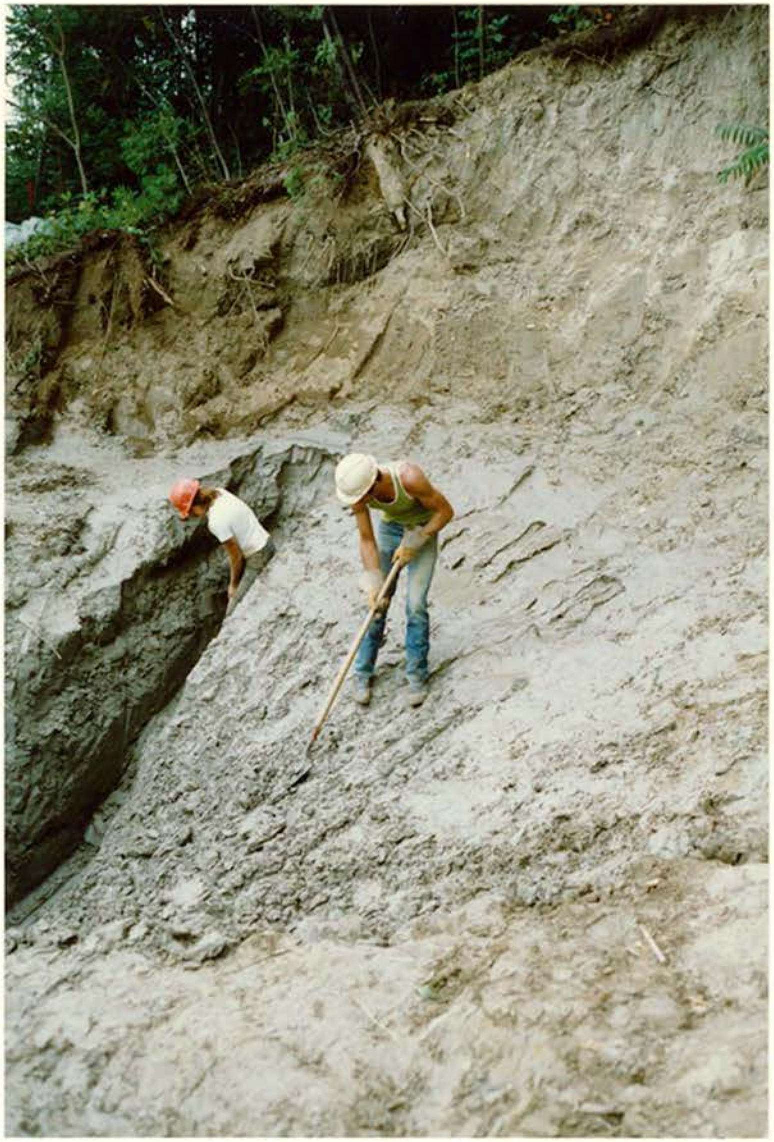


PHOTO 5: Excavation of Drainage Trench at West End of Site. Sloped Portion of Trench is in Lacustrine Silt.

PHOTO 6: Drain Pipe and Initial Lift of Filter Sand in Place at West End of Site.

PHOTO 7: Cleaning and Grading Lower Slope.

PHOTO 8: Excavation Complete (except for catch basin), August 31, 1989.

PHOTO 9: Demobilizing Case 580 Excavator (in two pieces).

PHOTO 10: Nearing Completion of Sand Filter and Granular "A" Placement.

PHOTO 11: Crane Working at the Limit of its Reach.

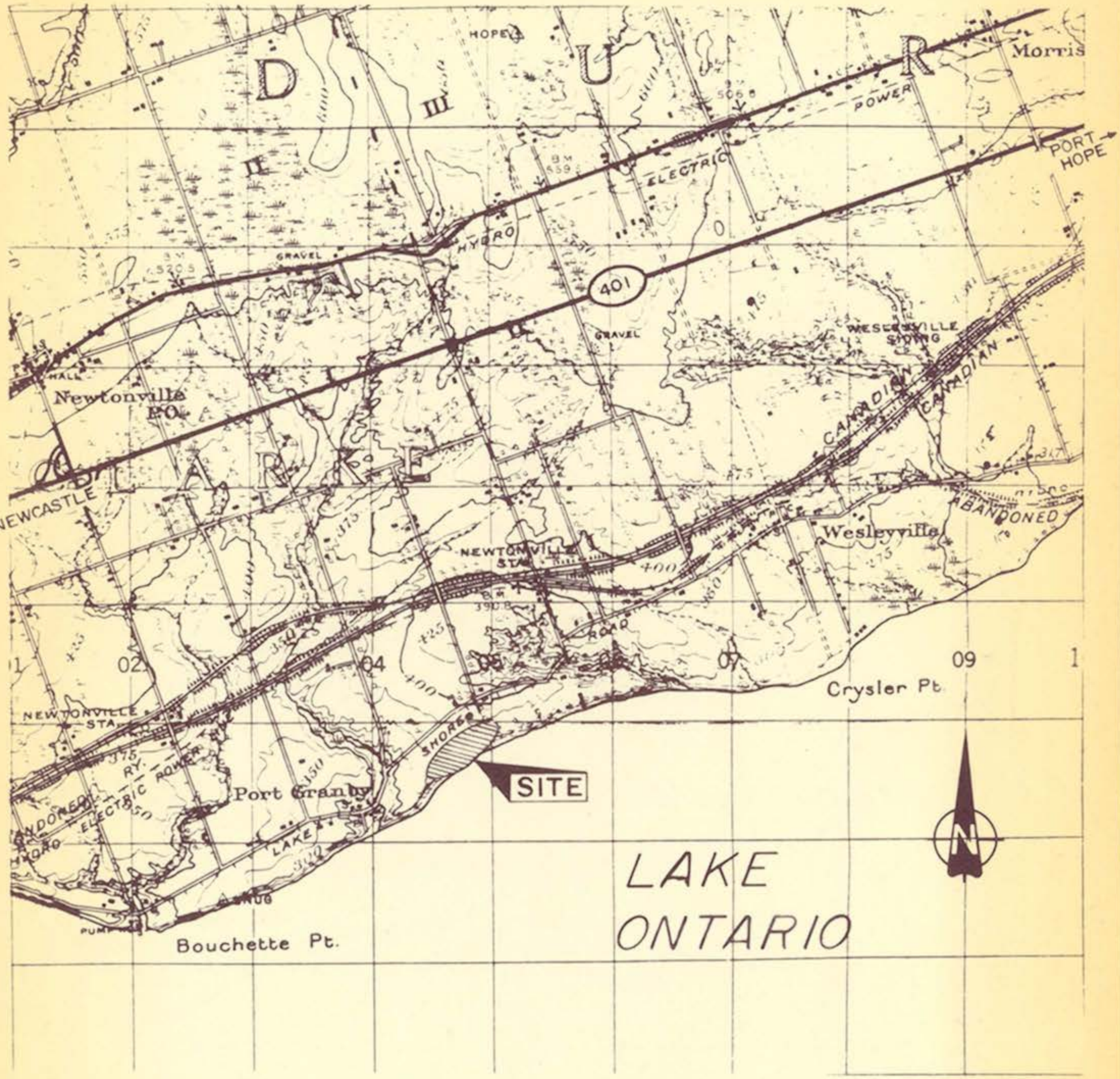
PHOTO 12: Rockfill Placement.

PHOTO 13: Topsoil in Place on Lower Slope.

PHOTO 14: Reconstruction Work Complete (except for regrading at the toe of the slope).

SITE LOCATION PLAN

FIGURE 1



SCALE 1:50,000

Date NOVEMBER 27·89

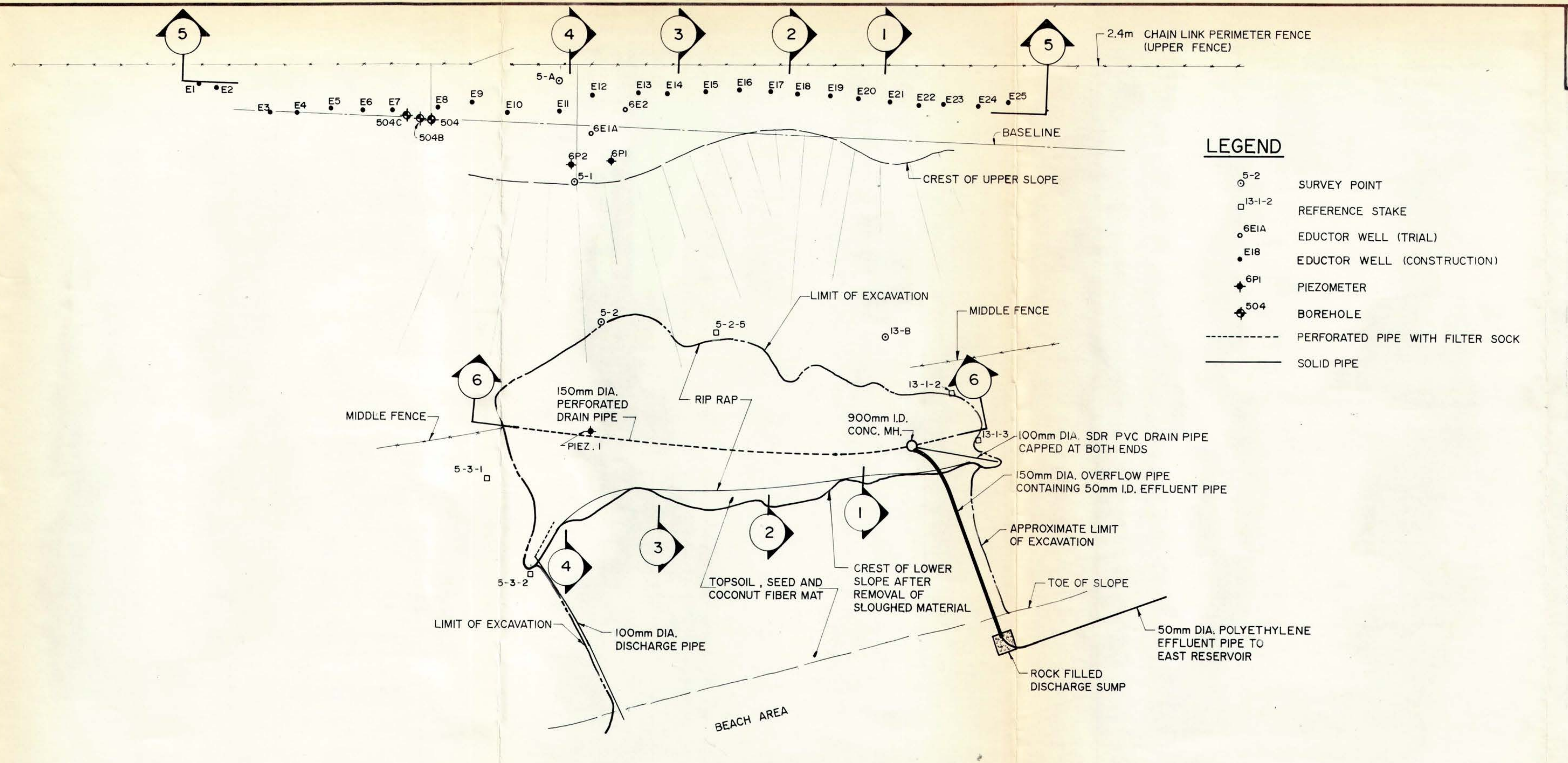
Project 891-1529

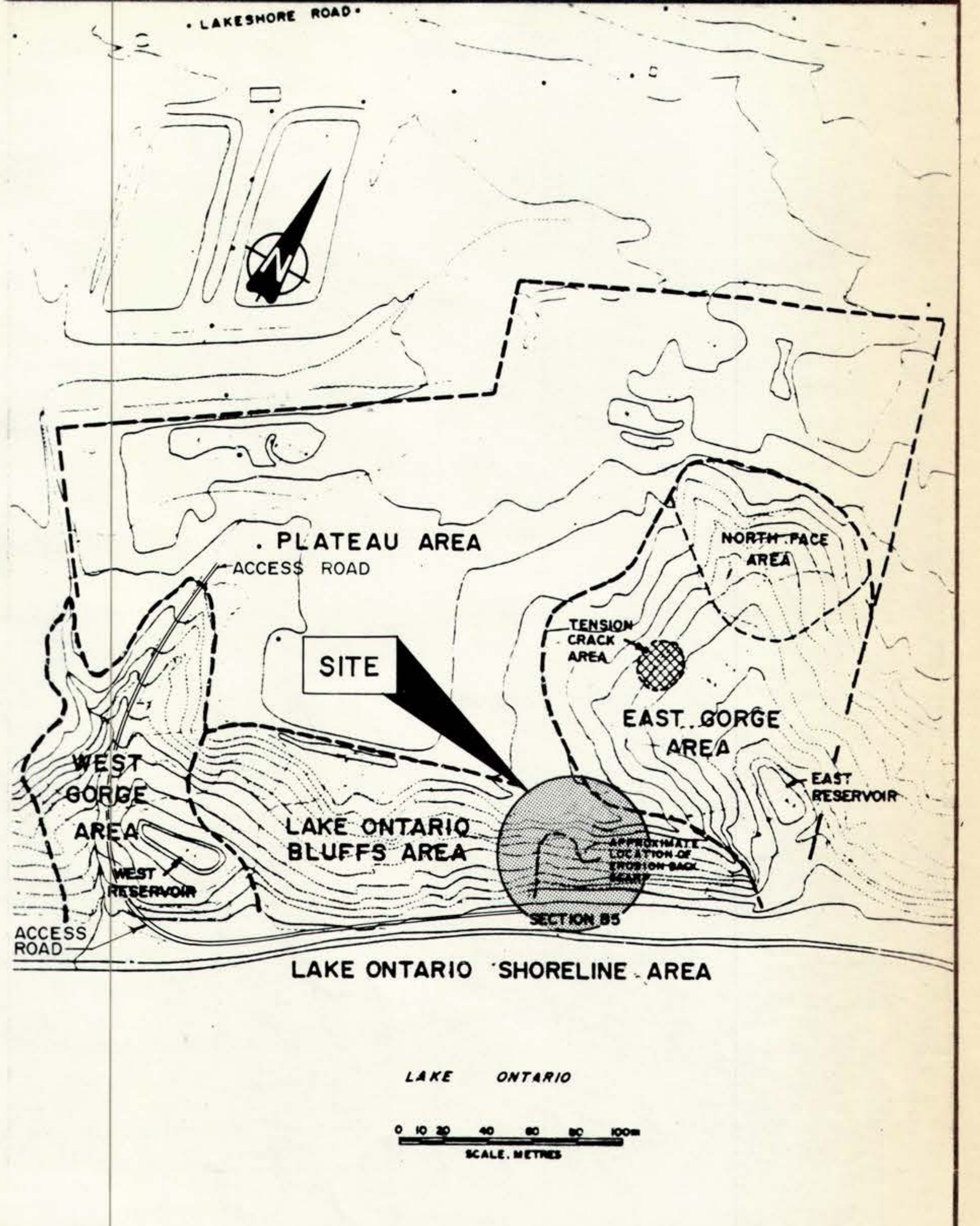
Golder Associates

Drawn TDR / R.B.C.

Chkd. [illegible]

FORM PRODUCED JUNE 1986





NOTE:

1. FOR SECTIONS REFER TO FIGURES 6 THROUGH 10.

SCALE 1 : 250

SITE PLAN

FIGURE 2

Date: NOVEMBER 27-89

Project: 891-1529

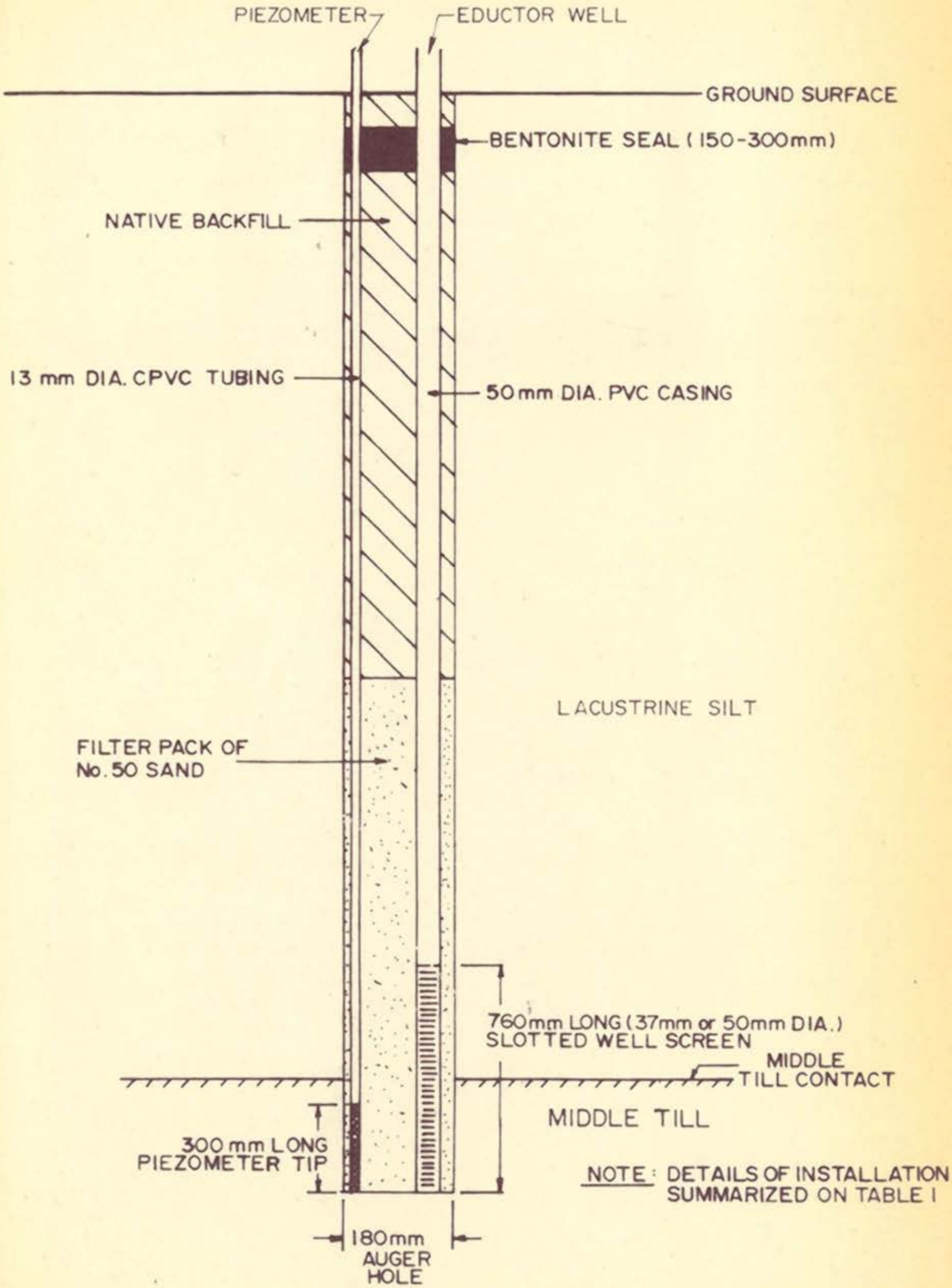
Golder Associates

Drawn: R.B.C.

Chkd: [illegible]

TYPICAL EDUCTOR AND PIEZOMETER INSTALLATION

FIGURE 3



NOT TO SCALE

Date NOVEMBER 27/89.

Project 891-1529

Golder Associates

Drawn TDR

Chkd

LEGEND

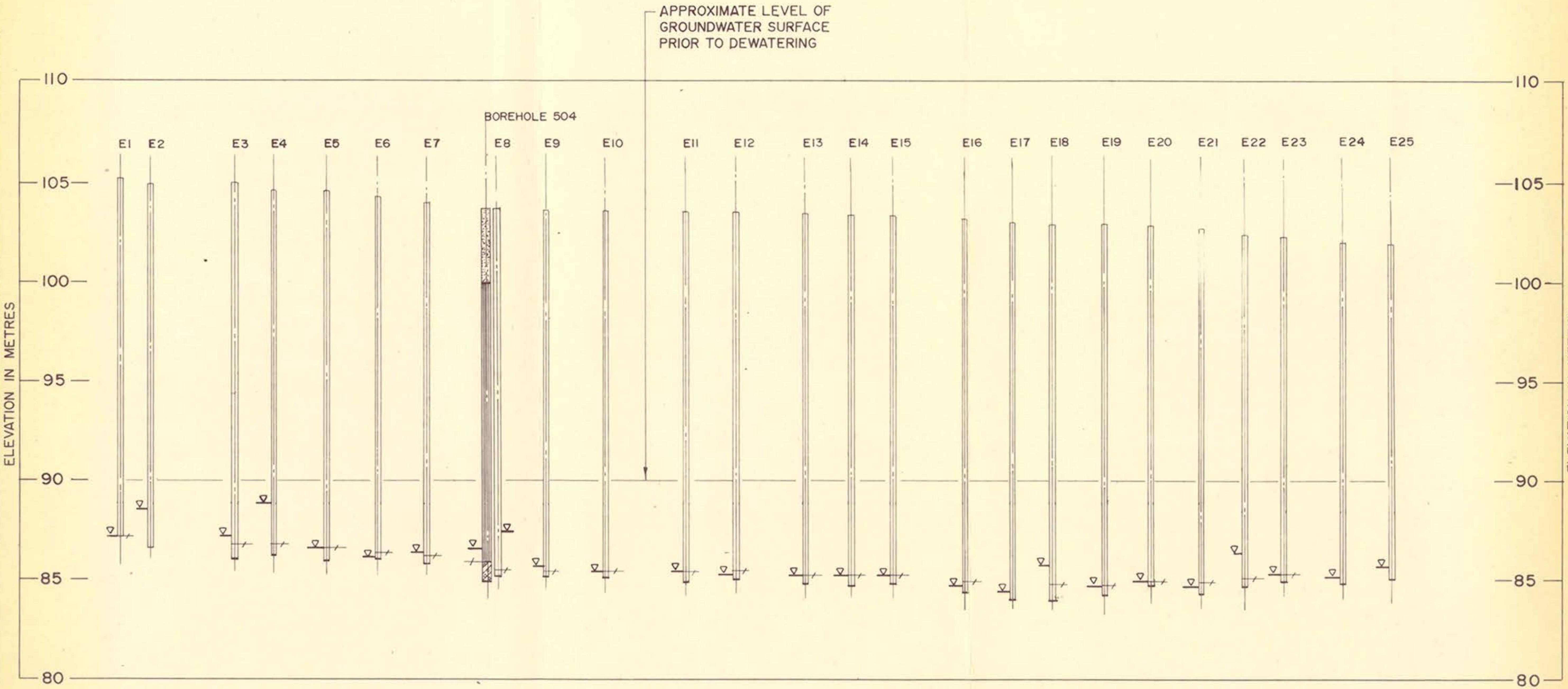
WATER LEVEL IN WELL - AUG.17, 1989.

INFERRED TILL SURFACE

END OF HOLE

SECTION 5 - 5
PROFILE ALONG EDUCTOR WELLS

FIGURE 4



SCALE 1:200

NOTE:

1. FOR PLAN LOCATION OF SECTION, REFER TO FIGURE 2.

Date NOVEMBER 27/89.
Project 891-1529

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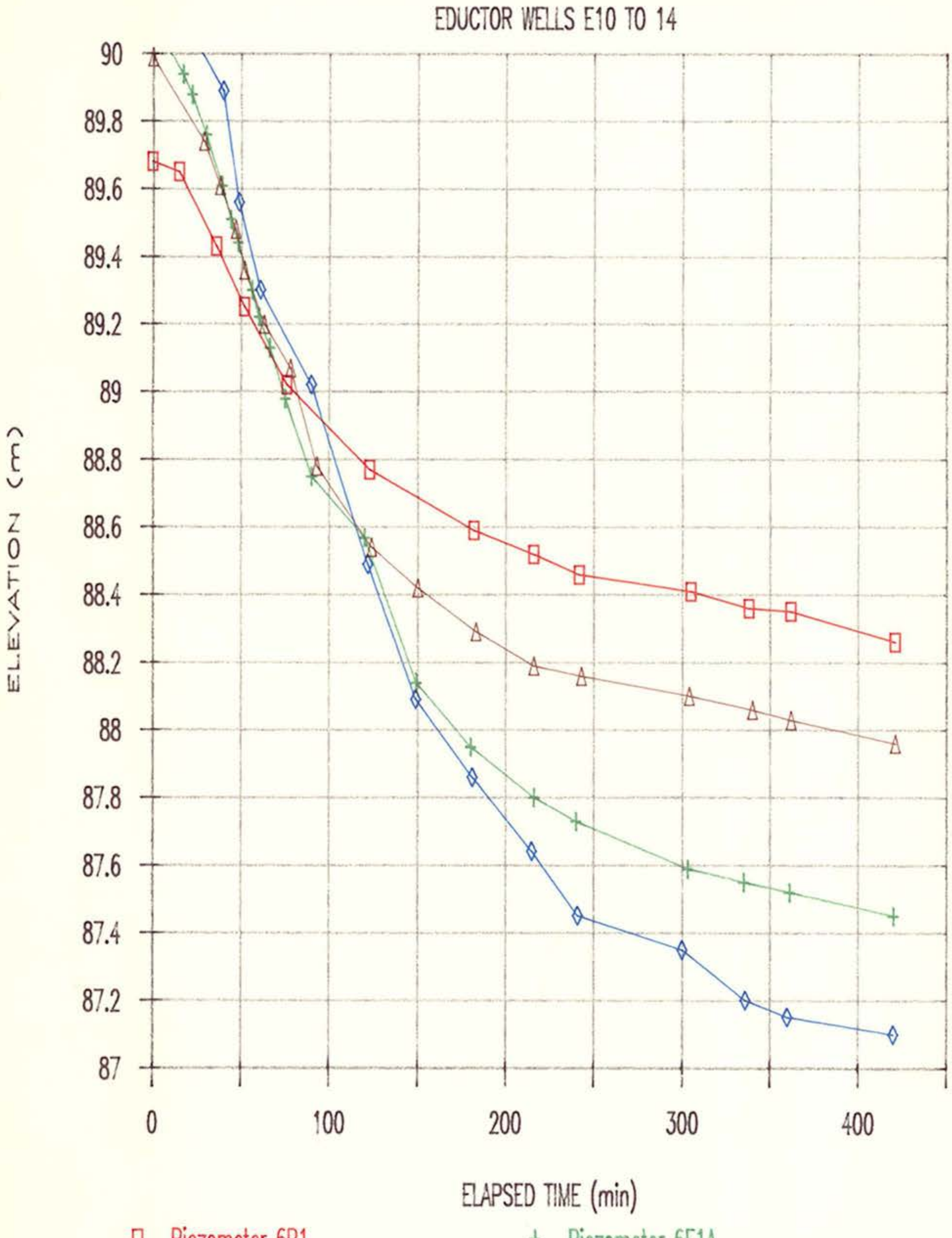
Drawn R.B.C.
Chkd

FIGURE 5

PIEZOMETER RESPONSE DURING PUMPING



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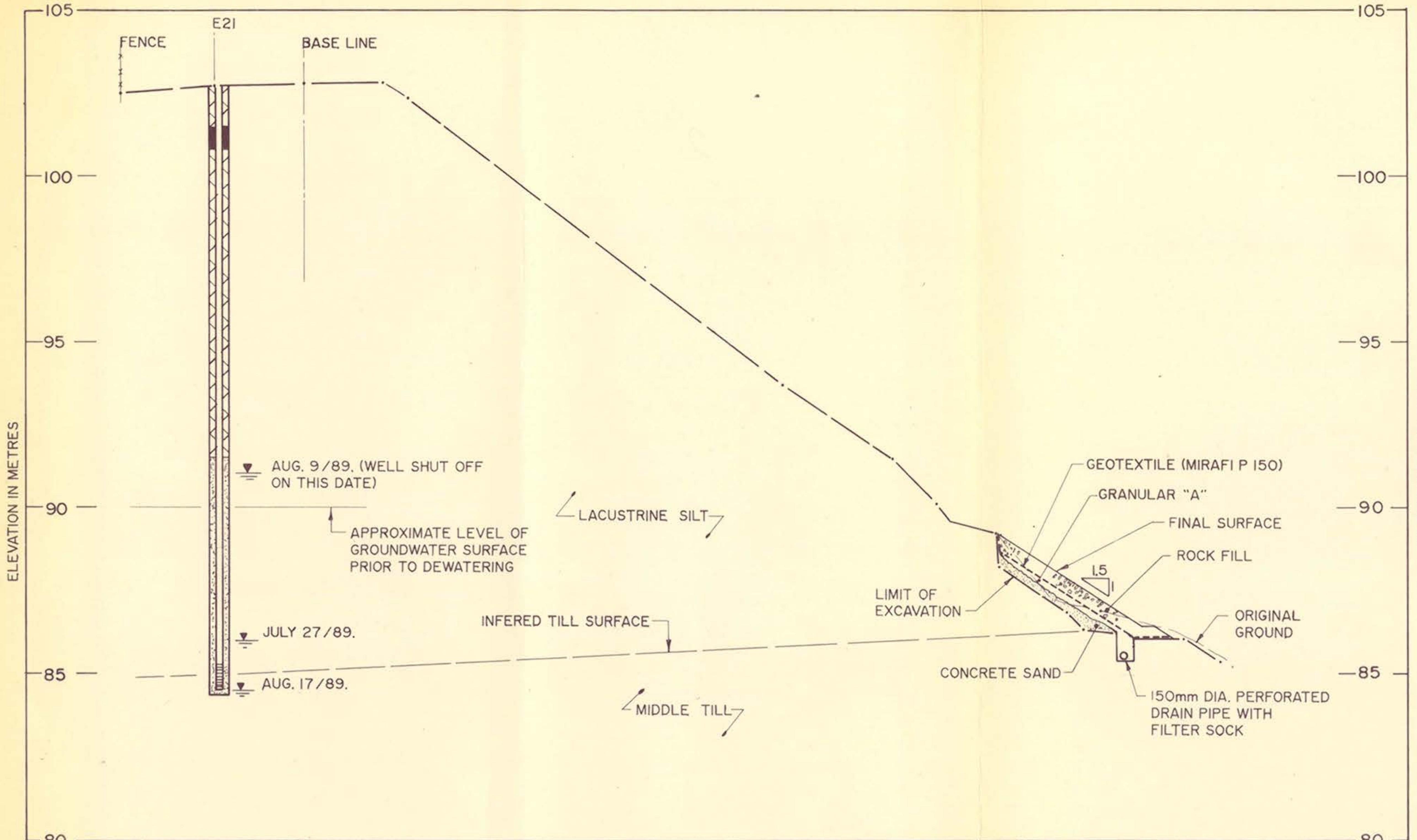
SECTION I - I

FIGURE 6



SCALE 1:125

NOTE:

1. FOR PLAN LOCATION OF SECTION, REFER TO FIGURE 2.

Date NOVEMBER 27/89.
Project 891-1529

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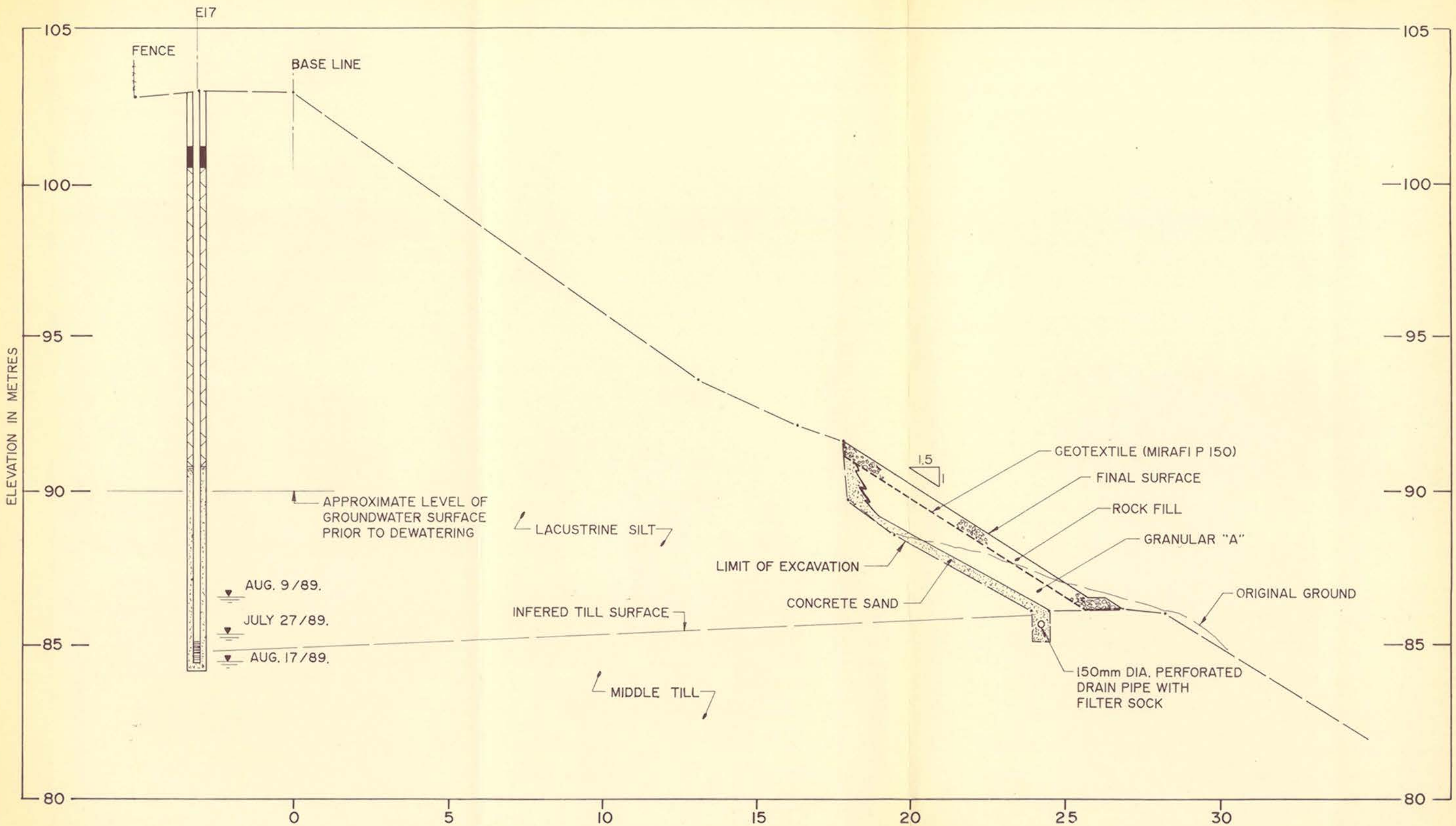
Chkd

SECTION 2 - 2

FIGURE 7



SCALE 1 : 125

NOTE:

1. FOR PLAN LOCATION OF SECTION , REFER TO FIGURE 2.

Date NOVEMBER 27/89.
Project 891-1529

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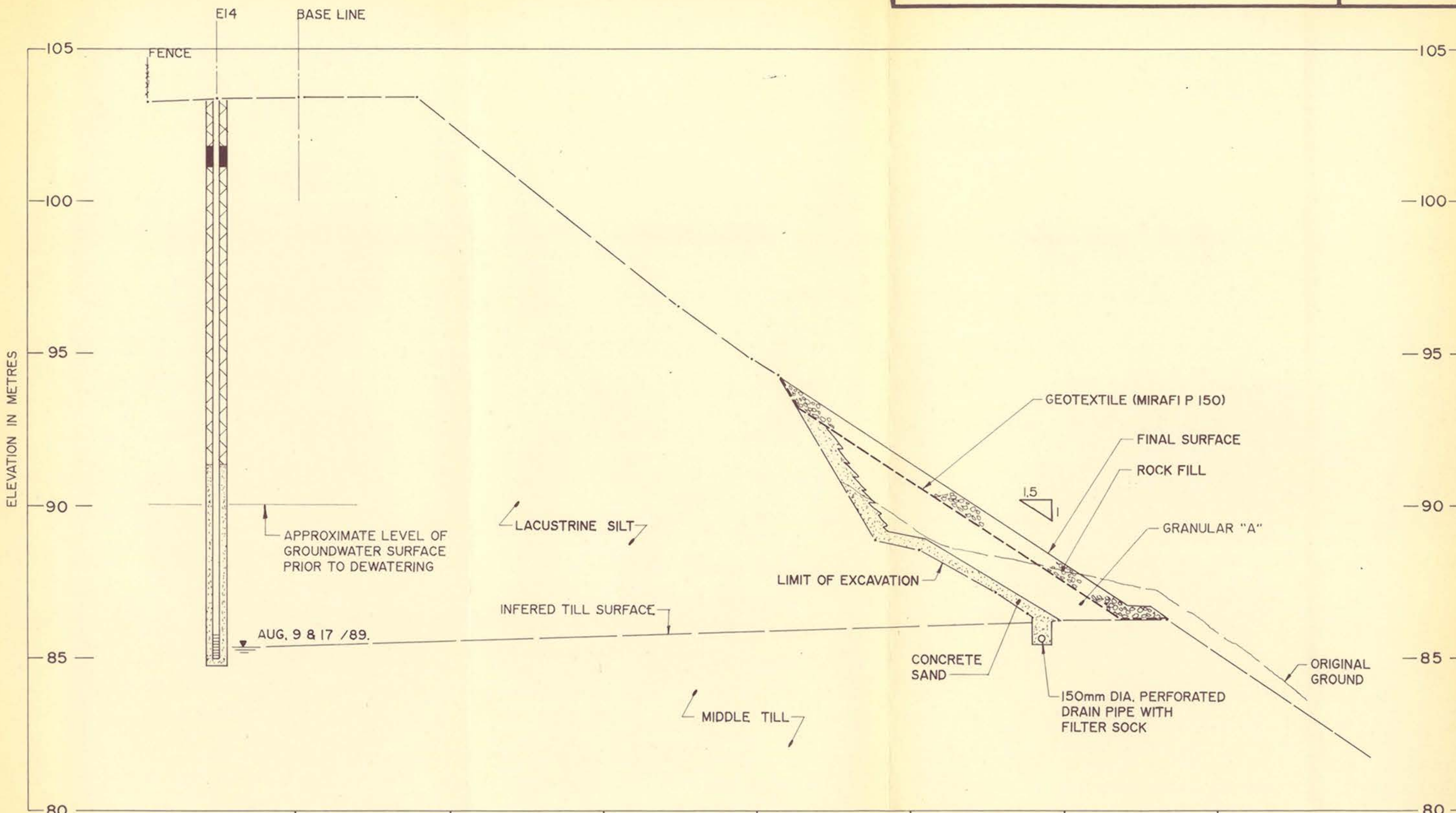
Chkd

SECTION 3 - 3

FIGURE 8



SCALE 1:125

NOTE:

1. FOR PLAN LOCATION OF SECTION, REFER TO FIGURE 2.

Date NOVEMBER 27/89.
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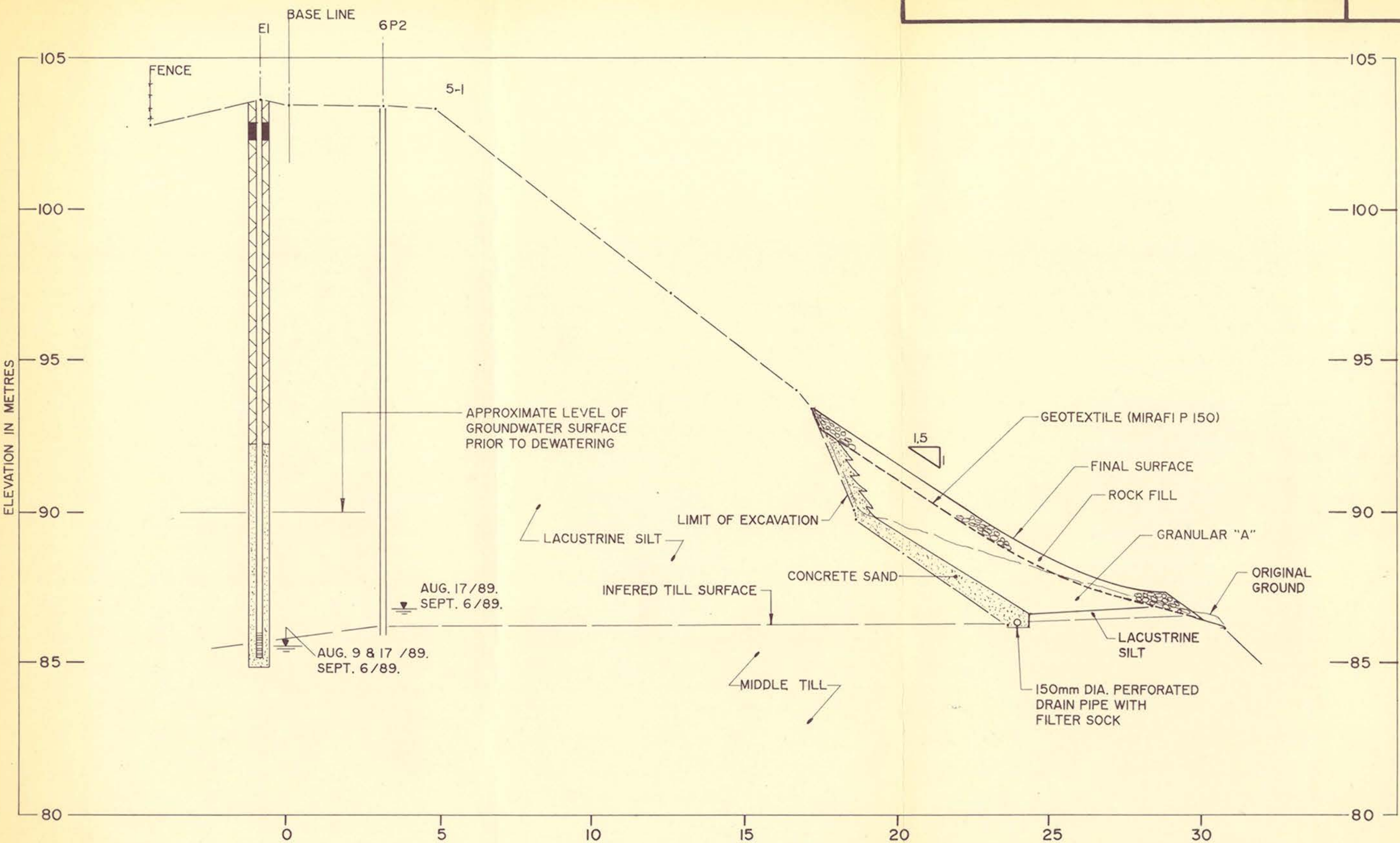
Chkd MRX

SECTION 4 - 4

FIGURE 9



SCALE 1:125

NOTE:

1. FOR PLAN LOCATION OF SECTION, REFER TO FIGURE 2.

Date NOVEMBER 27/89.
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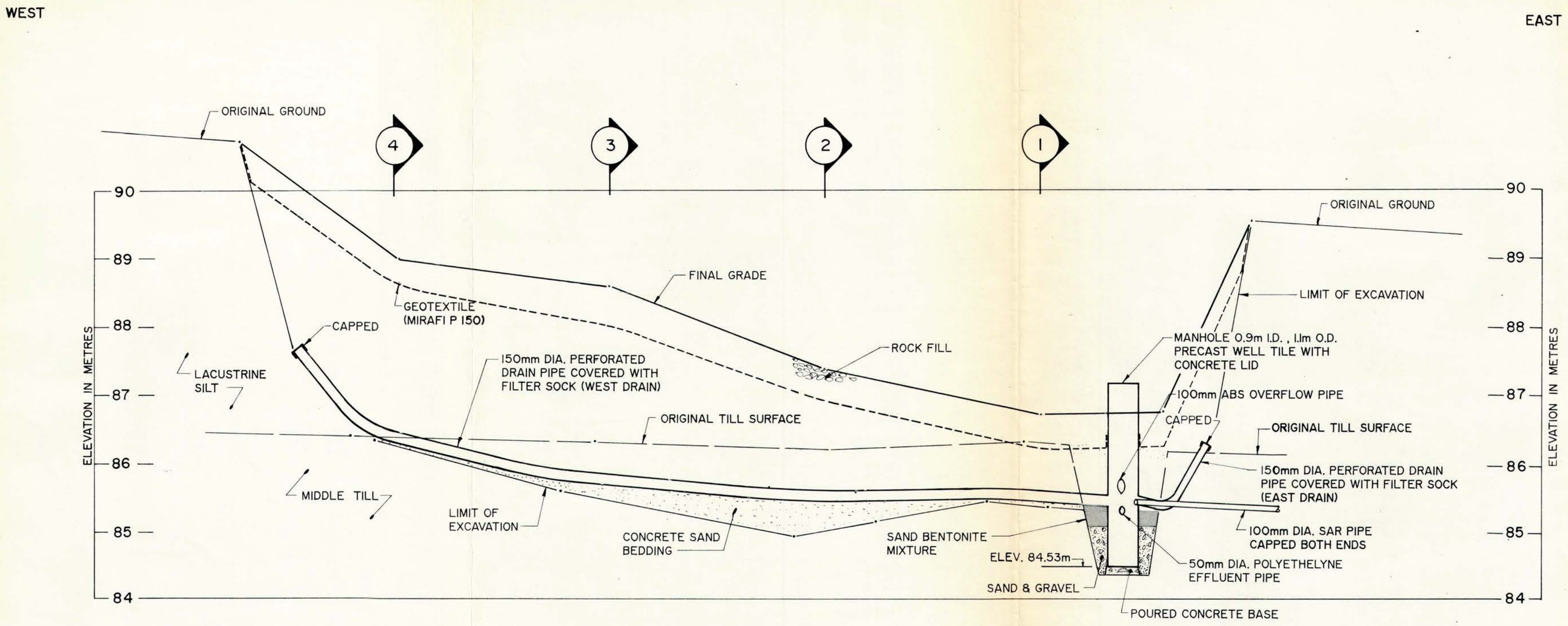
Drawn R.B.C.
Chkd MA

SECTION 6 - 6
PROFILE ALONG DRAINAGE SYSTEM

FIGURE 10



MANHOLE TABLE OF ELEVATIONS

INVERT WEST DRAIN	85.43m
INVERT EAST DRAIN	85.43m
INVERT SDR PIPE	85.42m
INVERT OVERFLOW	85.59m
INVERT EFFLUENT PIPE	85.36m
BOTTOM OF MANHOLE	84.53m

NOTES

1. ELEVATIONS RELATIVE TO BOTTOM OF MANHOLE ELEVATION 84.53 DETERMINED BY STADIA SURVEY RELATIVE TO BOREHOLE 504 ELEVATION 103.60m.
2. FOR PLAN LOCATION REFER TO FIGURE 2.

SCALE : HORIZONTAL 1 : 125
VERTICAL 1 : 50

Date NOVEMBER 27/89.
Project 891-1529

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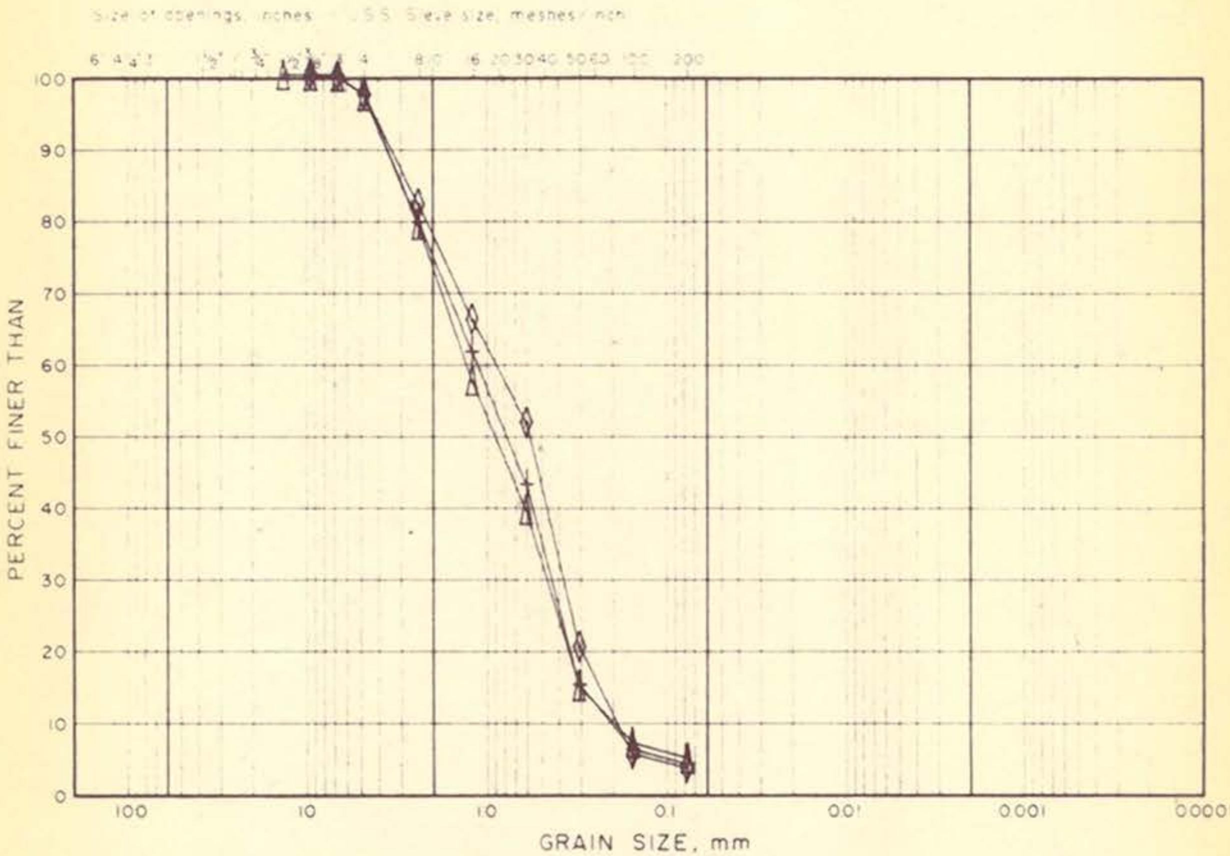
Chkd

GRAIN SIZE DISTRIBUTION

FIGURE 11

CONCRETE SAND



COBBLE SIZE	COARSE	MEDIUM	FINE	COARSE	MEDIUM	FINE	SILT SIZE	CLAY SIZE
	GRAVEL SIZE			SAND SIZE			FINE GRAINED	

LEGEND

SYMBOL	LOCATION	SAMPLE	DATE
+	PIT 60	1	89/08/17.
◊	PIT 60	2	89/08/17.
Δ	PIT 60	3	89/09/20.

Project 891-1529

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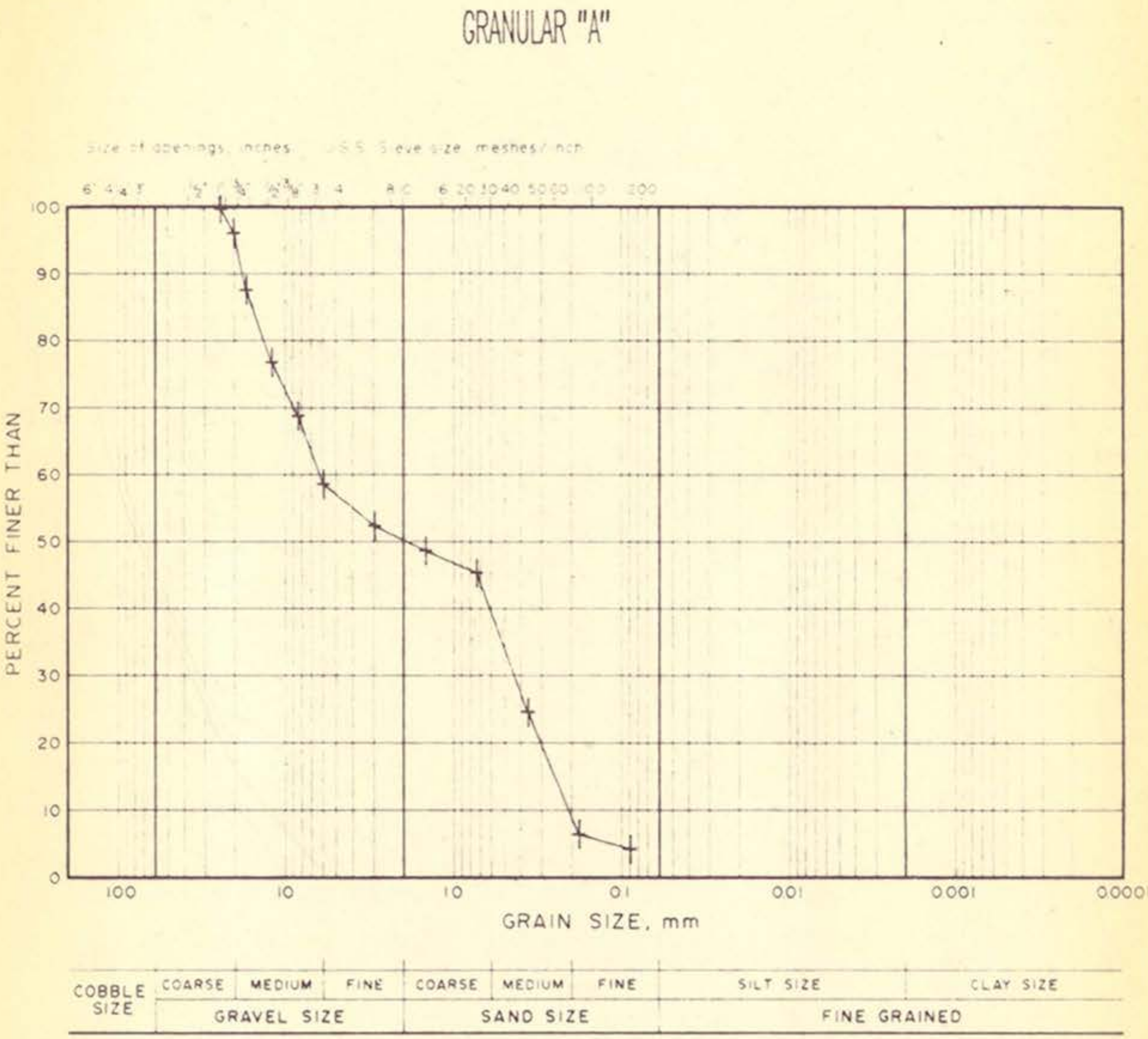
GRAIN SIZE DISTRIBUTION

FIGURE 12



LEGEND

SYMBOL	LOCATION	SAMPLE	DATE
+	PIT 60	1	89/09/20.

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