

Lesson to be learned in public presentations

Put imp. points & notes directly on copy of VU-GRAPHS in the order of presentation. For examples see VU-GRAPH GES-53

4/26/82 15/B3
1 of
J. Kane

General Description of Plant Fill Problem and Its Extent

VU-GRAPH
NO.

Remarks

I will attempt to cover the most important aspects for all affected recognition that this meeting's primary purpose is to discuss the more difficult and specialized remedial fix - that of underpinning

I will purposely avoid going into the large amount of data and details which have been developed to resolve the Midland plant fill problem - in hopes that it will permit more time to address areas of special interest that the Committee may have, which will be identified by your questions.

To assist in responding to ACRS questions - we have representatives from the Corps of Engineers and Geotechnical Engineers, Inc. These Consultants have assisted the Staff in the safety review of the Midland project in the geotechnical engineering area.

My presentation will attempt to briefly cover:

1. General Description of Plant Fill Problem and Its Extent
2. Remedial Measures Proposed To Eliminate Foundation Support Problems
3. Areas of ^{general} Agreement reached between the Staff and the Applicant with respect to the Proposed Fixes.

It is planned that Mr. Frank Rinaldi will follow and briefly ^{address} describe the structural aspects of the proposed fixes. Also Dr. Chen on underground piping and Dr. Pavlos on underpinning monitoring. Following ^{these} presentations we plan to have discussions on the various monitoring requirements for the various fixes which the Applicant has committed to carrying out.

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J. Kane

General Description (cont.)
Remarks

WU-GRAPH
No.

GES-1

Show plan view of Cat-I structures on competent natural soils and on plant fill
Plant grade El. 634 - Top of natural soil El. 600 ± - Top of hard-stiff natural
silty CLAY w/ silt, ^{sand} and gravel varies El. 585 to 600
Bedrock is quite deep (Lk. black SHALE) El. 240 ±
Distinguish separation from reactor Bldg.

BASIS for CONCLUDING we have plant fill problem:

GES-2
GES-3
GES-4
GES-5

- DGB comparison of estimated versus actually measured settlements ^{includes surcharge effect}
- Settlement of Plant Fill Under Its Own Weight - Include plan of boros anchors
- Settlement of 8" service water line within the surcharge area (Max settlement = 1.35')

- In addition to observing large settlements - we have the results of an extensive subsurface exploration program which was undertaken in late 1978 when the settlement problem at the DGB became known

- The boring results indicate the plant fill between El. 634 and El. 600 is highly variable, ^{in consistency} with soft clay and loose sand zones intermixed with densely compacted zones

GES-6
GES-7

Sample borings CH-2 and PD-27 show loose sand fill

Other borings, such as the AA series, show soft clay fill beneath the EPA with blow counts as low as 2, 3 and 4

Not acceptable fill mat'ls. or indicative of well compacted fill

Other indicators of the plant fill problem include ^{- DGB-BLAST} CRACKING of structures, results of plate load test and re-examination of computer-aided records

We also have ^{some} cracking of structures at orientations you would suspect because of settlements that have been experienced or because of known weak foundation conditions.

CONSISTENCY		
clay	sands	
soft	N 2 to 4	4 to 10 Loose
med.	4 to 8	10 to 30 Medium
stiff	8 to 15	30 to 50 Dense
v. stiff	15 to 30	

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General Description (cont.)

Remarks

VU-GRAPH
No.

Results of plate load tests on the clay fill show it to be less stiff than you would anticipate for a material compacted to 95% max. dry density (Modified Proctor)

A reexamination of the compaction control test records would also lead to the conclusion that the required level of compaction was not achieved

Summarizing the safety-related structures and utilities affected by the plant fill problem include:

EPA, C.T., FIVP & RR area

GES-8

Plan of Auxil. Bldg. area

GES-9

List of affected structures w/ identified foundation support problem

GES-1

Plan of structures on fill (DGB, SWPS, Diesel Fuel Oil Tanks, BWST, Under-Piping)

GES-10

List of affected structures w/ identified foundation support problem

REMEDIAL MEASURES PROPOSED TO ELIMINATE FDN PROBLEM

Will cover **BRIEF DESCRIPTION of FIXES** and indicates status of agreement on safety review issues related to **FOUNDATION STABILITY**

VU-graph No.

GES-50
GES-51

Identify structures

Note remedial measures include:

- Underpinning
- Removal & Replacement
- Installation of Term. Dewater. System
- Surcharging nearly completed structure
- Rebedment & Replacement

for pipes

AUXILIARY BUILDING AREA

GES-52 Note that package has plan view but VU-Graph not available

Note individual structures

Note reactor containments are ^{NOT} connected to Main Auxiliary Bldg

Note that EPA, C.T., and RR piping are structurally connected

Give approximate dimensions of C.T. & EPA

Show section location for next VU-GRAPH

GES-53

Auxiliary Building Section

See marked up slide

- 1st describe structures & fdn elevations
- 2nd Fdn conditions
- 3rd Staff assessment of fdn adequacy

SERVICE WATER PUMP STRUCTURE

Remarks

NO-CRASH IT

- GES-54 Show location of SWPS in relation to other structures
- GES-55 Show enlarged plan of SWPS - Distinguish between portion on fill & fill
- GES-56 Show sectional view A-A which includes proposed underpinning wall @ E. 587
Describe imp. f.d.n. elevations

Foundation layer ^{will be} ~~is~~ a hard sandy CLAY ^{or a dense silty clay} fill, that has top elevation around 590
 (IV medium = 75 blows (range 50 to 120), LL 17, PL 11, $w_n = 17\%$, $S_{total} = 145\%$, $S_{dry} = 134\%$
 $f = 50$ to 70% , ^{adapted} ~~medium~~ undrained shear strength of 8 ksf E of 6,000 to 9,000 ksf.
 Preconsolidation stress up to 40 tsf)

~~Dense silty clay~~

The Staff and its Consultants concur with the Applicant that the hard sandy CLAY ~~and dense silty clay foundation~~ ^{is} ~~are~~ competent and acceptable foundation materials to support the proposed permanent underpinning wall and thereby eliminate the plant fill problem in the SWPS area.

Foundation monitoring during construction will include checking groundwater, verifying adequate bearing capacity, soil modulus, settlement characteristics and controlling maximum elevation differences between adjacent pier bottoms

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J. Kunc

BOCRATED WATER STORAGE TANKS

No - Graph No

Remarks

GES-54 Show location of BWSJ (Tank loading of 2000 psf)

GES-57 Show BWSJ Section - Stainless steel tanks, each 32' high, 52' in ϕ

The ~~base~~ base of the tanks are founded on a compacted granular fill and the tank walls are founded on a ring wall foundation at elevation 627. The base of the granular fill and the base of the ring wall are founded on compacted cohesive fill that is approximately ^(CL-MU) 3 feet thick. Below the fill lies either hard-very stiff clays or in some locations dense natural sands. The fill itself consists of medium to v. stiff clay with medium to dense natural sand ✓

To demonstrate the adequacy of the BWSJ foundations, the Applicant filled the tanks with water to surcharge the plant fill. Shortly thereafter cracks (0.63 inch limit 1 & 0.35 inch limit 2) were discovered in the ring wall foundation near the juncture of the tanks and the valve pit structures.

Technical

Differences in technical opinion do exist between the Staff and the Applicant as to what was the major cause of the cracking. **a design inadequacy where a non-unif.**

Applicant - Major cause was ~~non-uniform~~ loading between valve pit and ring wall which resulted in differential settlements and localized areas of over stress

Staff - Consider the major cause to be inadequate compaction that lead to unanticipated larger settlements

In spite of these differences - the Staff and Applicant have reached agreement on the acceptability of the proposed fix

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BURATED WATER STORAGE TANKS (cont.)

W-414111 no.

Remarks

that of constructing a new reinforced concrete ring beam around the existing ring beam and releveling Unit 1 tank (Suffered the largest settlement). Mr. Rinaldi to discuss.
New ring beam has been designed allowing for conservative estimates of differential settlement in the future

BWST foundation settlement will be monitored during years of plant operation as well as the critical stress areas between valve pit and the ring wall with a strain gage system. The objective of the monitoring will be to verify that differential settlements estimated in the redesign of the new ring beam are not exceeded and that ^{significant} cracking is not occurring

DIESEL GENERATOR BUILDING

GES-58

Show plan and sectional view of surcharged DGB area. The DGB is supported on continuous wall footings founded @ El. 628 (Approximately 25' to 30' of plant fill beneath structure). The plant fill is heterogeneous and consists of cohesive soils and granular soils, to a greater extent on the north side.

Surcharge Discussion

In July 1978, with the building about 60% complete, the settlements recorded indicated values greater than what had been anticipated for the entire plant life. Investigations showed the plant fill was settling under its own weight.

To correct the settlement problem, the Applicant elected to surcharge the DGB and complete the structure at the same time the surcharging was being placed

DIESEL GENERATOR BUILDING

W-graphs

GES-58

Describe surcharging (Placement of 20' of sand inside cut, etc)
~~So~~ Full 20' height of surcharge was held for about 4 1/2 months and then removed

We could spend the rest of the day discussing the Applicant's and the Staff's ~~positions on the~~ differences on evaluating the effectiveness of the surcharge program. The bottom line is, however, that we have reached agreement on the total and differential settlements which should be used in the structural analysis that evaluates the stresses induced by settlement. The Applicant is currently analyzing the stresses induced by settlements which occurred before and during surcharge. We are hopeful the results of these analysis will permit final resolution to be reached on the acceptability of the completed surcharge program.

UNDERGROUND UTILITIES

GES-59

- Show plan of buried G-listed Piping. Piping includes service water lines, diesel fuel oil lines (1 1/2" & 2"), berated water lines (18" & 24" ^{8", 10", 20" & 36" d}) and Control Room Pressurization Lines (1" & 4"). Most buried between 7' to 12'
- Completed explorations show plant fill beneath buried utilities to range from soft to hard silty CLAYS and loose to dense SANDS
- An extensive program to measure the settlement profiles of the service water piping was completed and revealed the pipes ranged from 4 to 14 inches below the design invert elevations and averaged approximately 7 inches below its intended design location

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J. Kune

UNDERGROUND UTILITIES (cont.)

No-graph

Remarks

The Staff concurs with the Applicant that a conservative estimate of maximum future settlement of buried utilities during plant life is 3 inches.

Action item remaining for the Staff is to review the proposed future monitoring program submitted by the Applicant

The evaluation of the settlement induced stresses in combination with other load combinations is to be discussed by Dr. Paul Chen, Consultant to MRC Mechanical Engineering Branch

PERMANENT DEWATERING

GES-60

Plan of Permanent Dewatering System

Permanent dewatering system is necessary because of potentially liquefiable loose sands in plant fill (above El. 610) in areas of DGB and RR Bay area. ^{Foundation problems with} Loose sand backfill at other locations (SWs, EPA, underground piping) have been remedied with other fixes

PERMANENT DEWATERING SYSTEM consists of:

20 Interceptor Wells - 20 Back-up Interceptor Wells
(Show location - located to pick-up main recharge source - cooling pond)

24 Area Wells

Capacity of each well is 10 gpm - Estimate ONLY 22 wells are needed to keep plant dewatered

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J. Kune

PERMANENT DEWATERING (cont.)

Operation of Dewatering System

- Maintain groundwater @ El. 575 during plant operation in DGB & RR Bay areas

This permits sufficient time, in the event of system failure, to either repair system or shut plant down before groundwater level reaches El 610 - the lower level where liquefaction is a concern

Monitoring of the dewatering system includes:

- Wells to show that Groundwater level is being maintained at or below El. 575
- Check on any removal of soil particles in discharge waters
- Water quality, ^{of collected water} is acceptable for discharge

Note location of six monitoring wells w/ alarms
Indicate other observation wells will also be operable

Cover Status of Agreement on Permanent Dewatering

Status of Agreement on Adequacy of Permanent Dewatering

3 - The Staff concurs with the Applicant that the two plant areas which require operation of the permanent dewatering system are the DGB area and Railroad Bay area, ^{as} ~~shown~~ on Fig. 4-1.

GFS Other plant areas where loose granular fill materials have been found have remedial measures planned, ~~which~~ which will eliminate the liquefaction potential problem

EPA & SLUS - Underpinning

Service Water Piping - fill removal & replacement & rebedment of pipes

The Staff agrees that maintaining the GWL below El. 610 in the DGB and Railroad Bay areas will assure plant safety against liquefaction type failure.

HES The Staff agrees that the 40 interceptor wells and 24 area wells are sufficient, with adequate redundancy, to maintain the water levels in the vicinity of the DGB and Railroad Bay area below elevation 610. (Based on analysis and drawdown test results)

HES The Staff concludes that in the event of a complete failure of the ^{permanent} dewatering system there would be at least 60 days before water levels would rise to elevation 610. beneath the DGB. Based on results of the recharge test we know the time would be greater than 60 days for the Railroad Bay area.

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Status of Agreement on Adequacy of Permanent Dewatering

- 6ES Although the permanent dewatering system is not technically a Seismic Category I system we consider its design, installation and monitoring program to be equal to Seismic Category I requirements.
- 6ES To show compliance with requirements in the Branch Technical Position on Permanent Dewatering (SRP Section 2.4.12), the Staff requested, ^{that} the Applicant demonstrate the system could maintain water levels below elevation 610 in the event of break of ~~the~~ ^{26-inch diameter} a buried, circulating water discharge line ~~and~~ ^{or} a 20-inch diameter condensate water pipe near the DGB.

Based on the results of the Applicant's studies where conservative assumptions were made on pipe break conditions and on hydraulic parameters, the Staff ^{agrees with the Applicant and} concludes that failure of either of these lines will not result in groundwater levels above the design level of elevation 610.

The Staff concludes that the ^{only} major remaining item on permanent dewatering is the resolution of the Technical Specification, ^{requirements} ~~details~~ during years of plant operation.



List of Vu-graphs for ACRS Presentation - Geotechnical Engineering

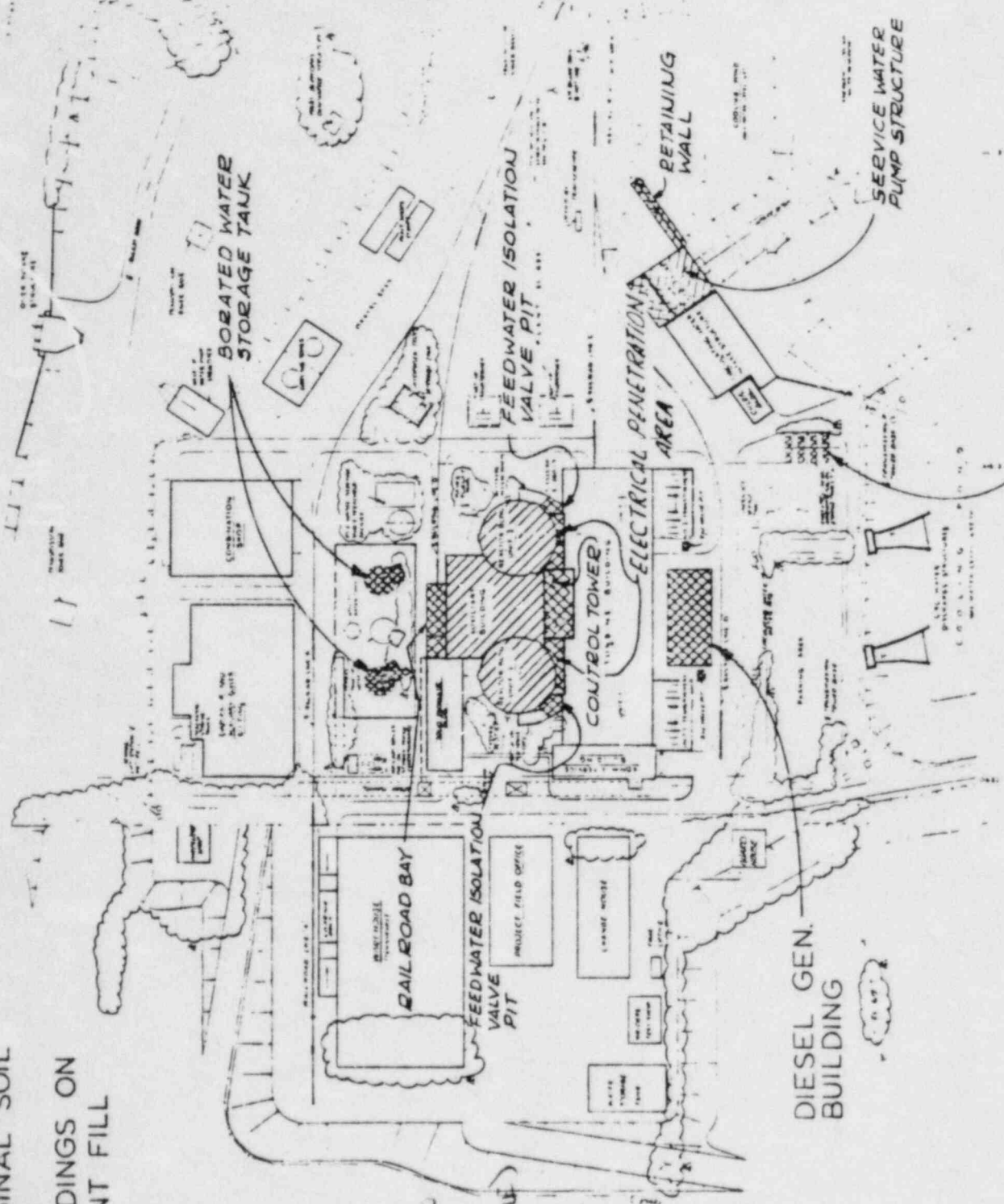
Vu-graph No.	Identification
GES-1	Plan view - Cat. I structures on natural soils and on plant fill.
GES-2	DGB Plan - Estimated versus Measured Settlements
GES-3	Site Plan with Location of Borros Anchors
GES-4	Plot of Settlement of Plant Fill Under Its Own Weight
GES-5	Settlement Profile of 8" Service Water Line
GES-6	Sample Boring Log CH-2 and PD-27
GES-8	Auxiliary Building Plan of Settlements
GES-9	List of Affected Structures in Auxil. Bldg, Area w/Foundation Problem.
GES-1	Plan view - Cat. I structures on natural soils and on plant fill.
GES-10	List of Affected Structures w/Foundation Problem
GES-50	List of Affected Structures w/Proposed Fixes
GES-51	List of Affected Structures w/Proposed Fixes
GES-52	Auxiliary Building Plan
GES-53	Auxiliary Building Section
GES-54	Site Plan
GES-55	Service Water Pump Structure - Plan
GES-56	SWPS Section

Vu-graph No.	Identification
GES-57	BWST Section
GES-58	Layout of Surcharged Diesel Generator Building Area
GES-59	Plan of Buried Q-Listed Piping
GES-60	Plan of Permanent Dewatering System
GES-61	Monitoring - Auxiliary Building Plan
GES-62	Monitoring - Auxiliary Building Section
GES-63	Monitoring - Service Water Pump Structure

J. Kane
4/20/82

GES-1

- CLASS 1 Structures
-  BUILDINGS ON ORIGINAL SOIL
-  BUILDINGS ON PLANT FILL



see same cut I
 Show structures on
 natural soils & on plant fill
 Imp't. Elevations
 Plant grade El 634
 Top of natural soils El 600
 Top of hard-stiff competent
 penetration clay, El 585 to 600
 Bedrock is quite deep (4th SHALE)
 ~ El 240 ±

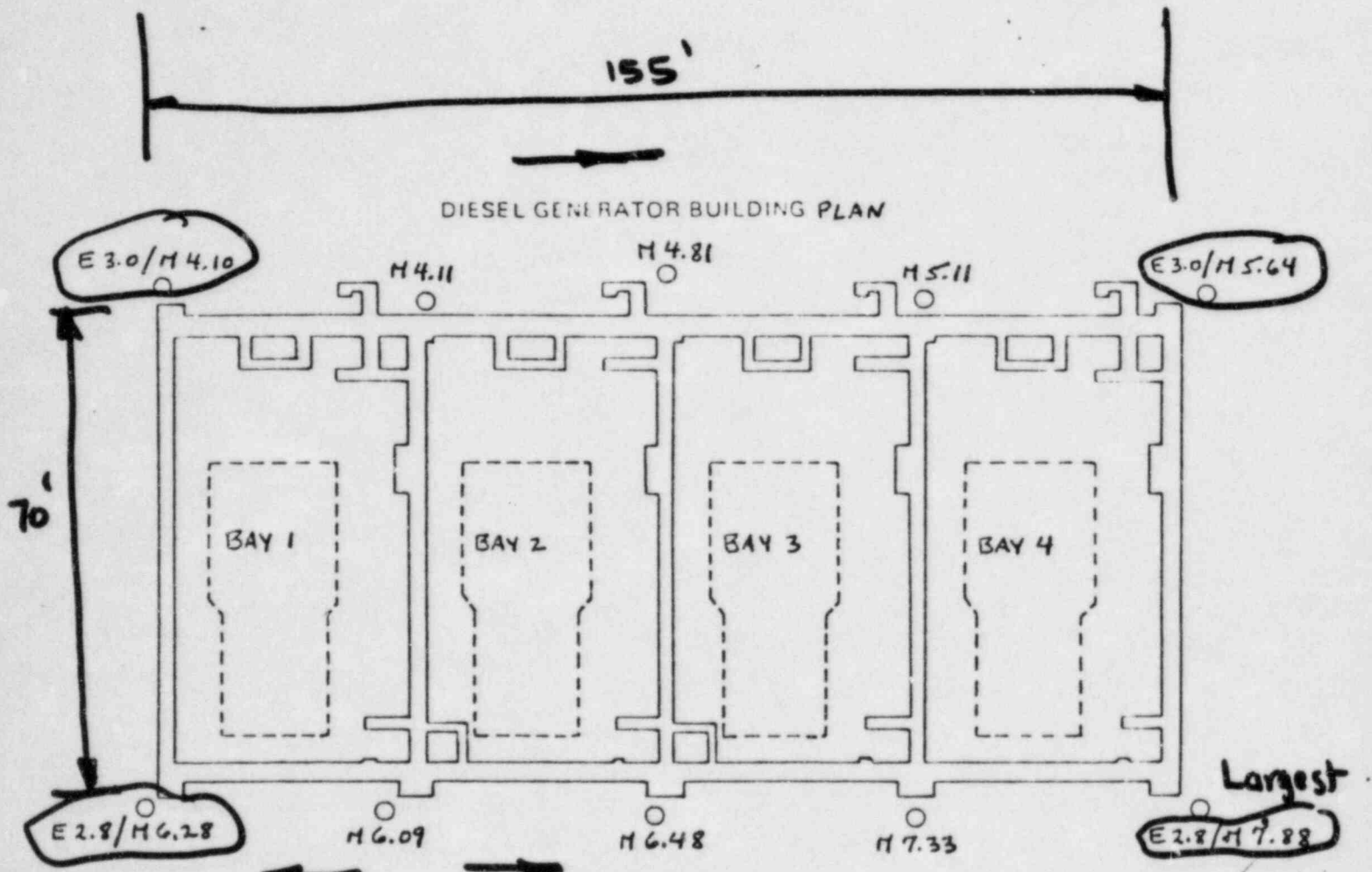
DIESEL GEN.
BUILDING

EMERGENCY DIESEL
GENERATOR FUEL OIL
STORAGE TANKS (U.G.)

Basis for concluding we have plant fill problem

Some structures have experienced larger than anticipated settlements

DGB - comparison of estimated versus measured



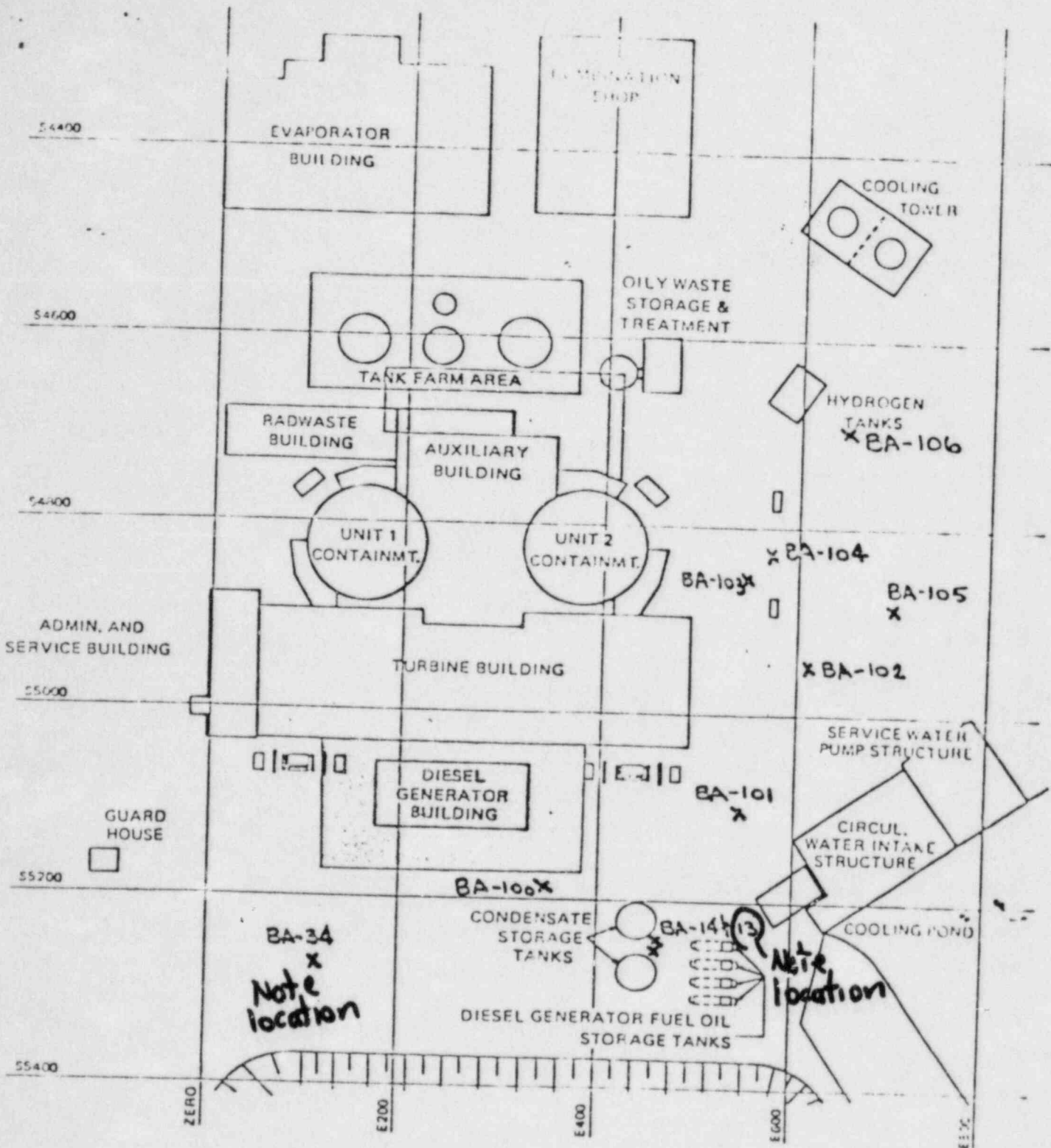
LEGEND:

- — BUILDING / PEDESTAL SETTLEMENT MARKER
- SETTLEMENT IN INCHES

E 3.0 / M 5.64
ESTIMATED / MEASURED AS OF 12/81
for 40yr
plant
life

Largest
Include
settlements
under
surcharge

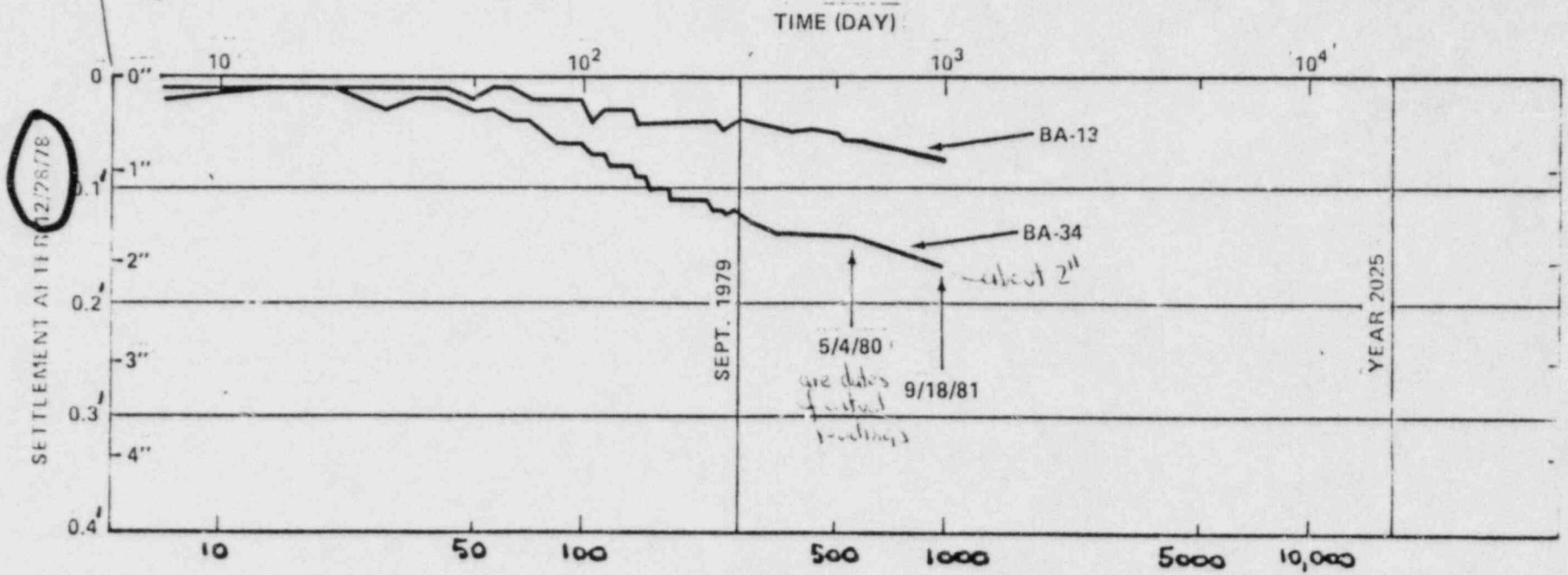
ESTIMATED VERSUS MEASURED
SETTLEMENTS



BORROS ANCHOR LOCATIONS

Fill reached plant grade
in 1977 (one year later
when settlement was measured)

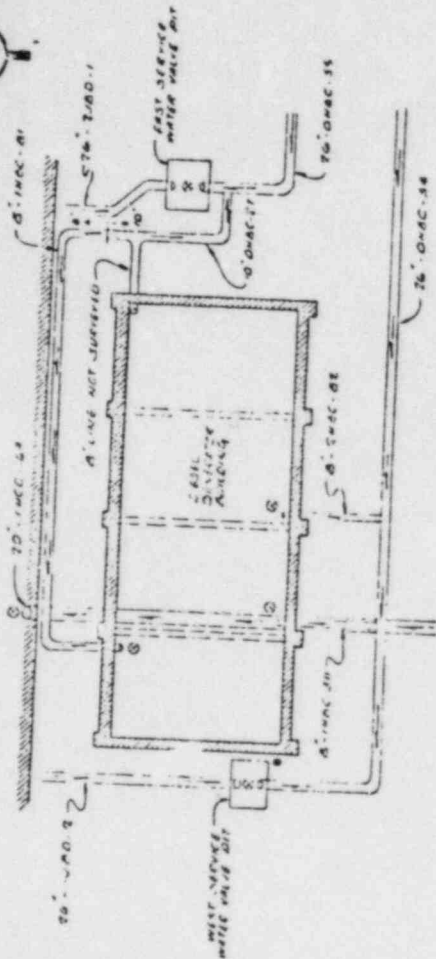
Reason for difference in settlements (BA-13 & BA-34)
is likely due to the highly variable fill densities



SETTLEMENT OF PLANT FILL UNDER ITS OWN WEIGHT



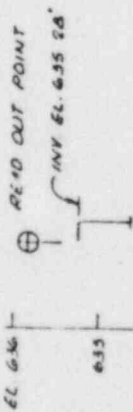
TURBINE BUILDING



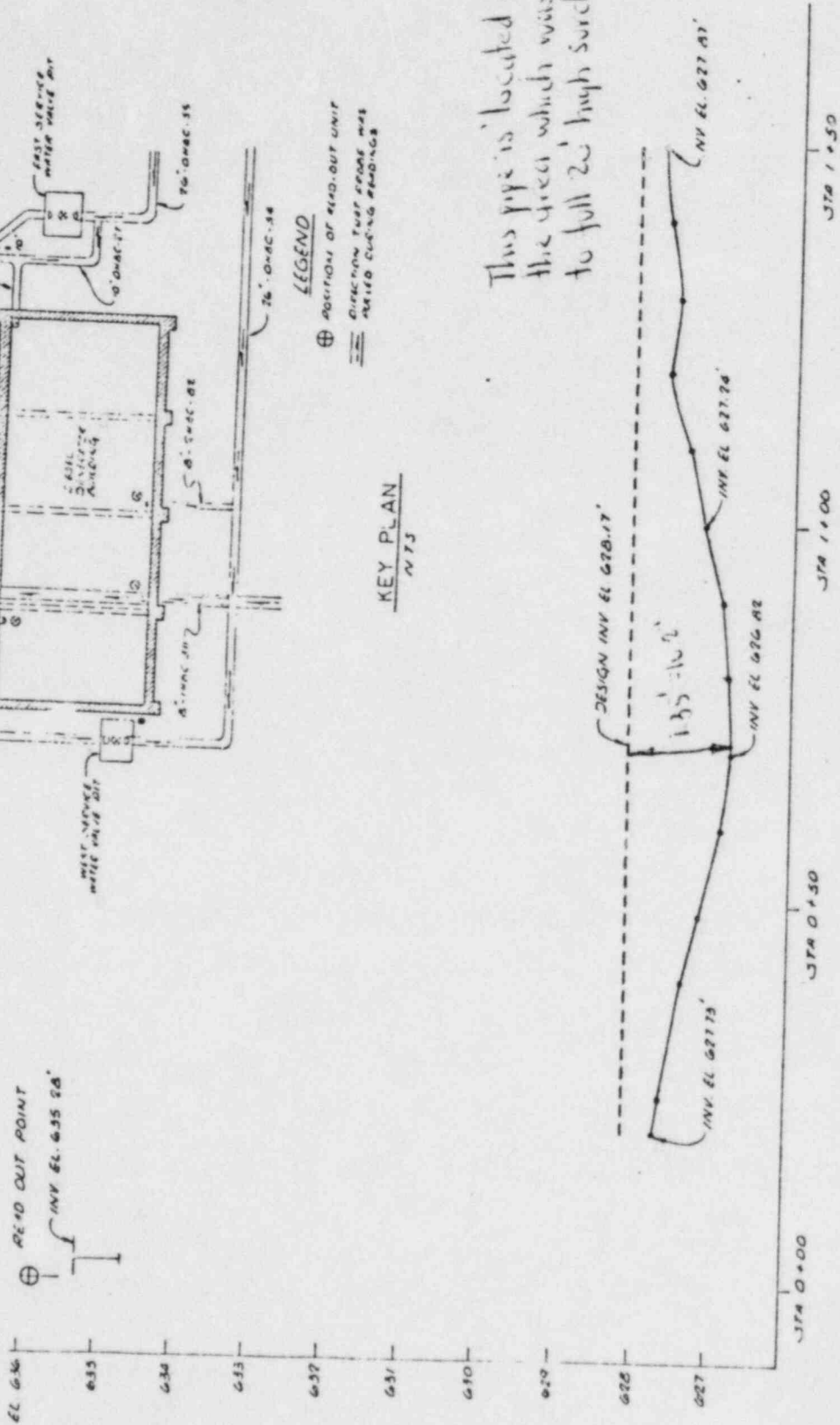
LEGEND

- ⊕ POSITION OF READ-OUT UNIT
- ≡ DIRECTION THAT FLOOD WAS PAUSED DURING SURVEYING

KEY PLAN
N 73



This pipe is located within the area which was subjected to full 2' high surge



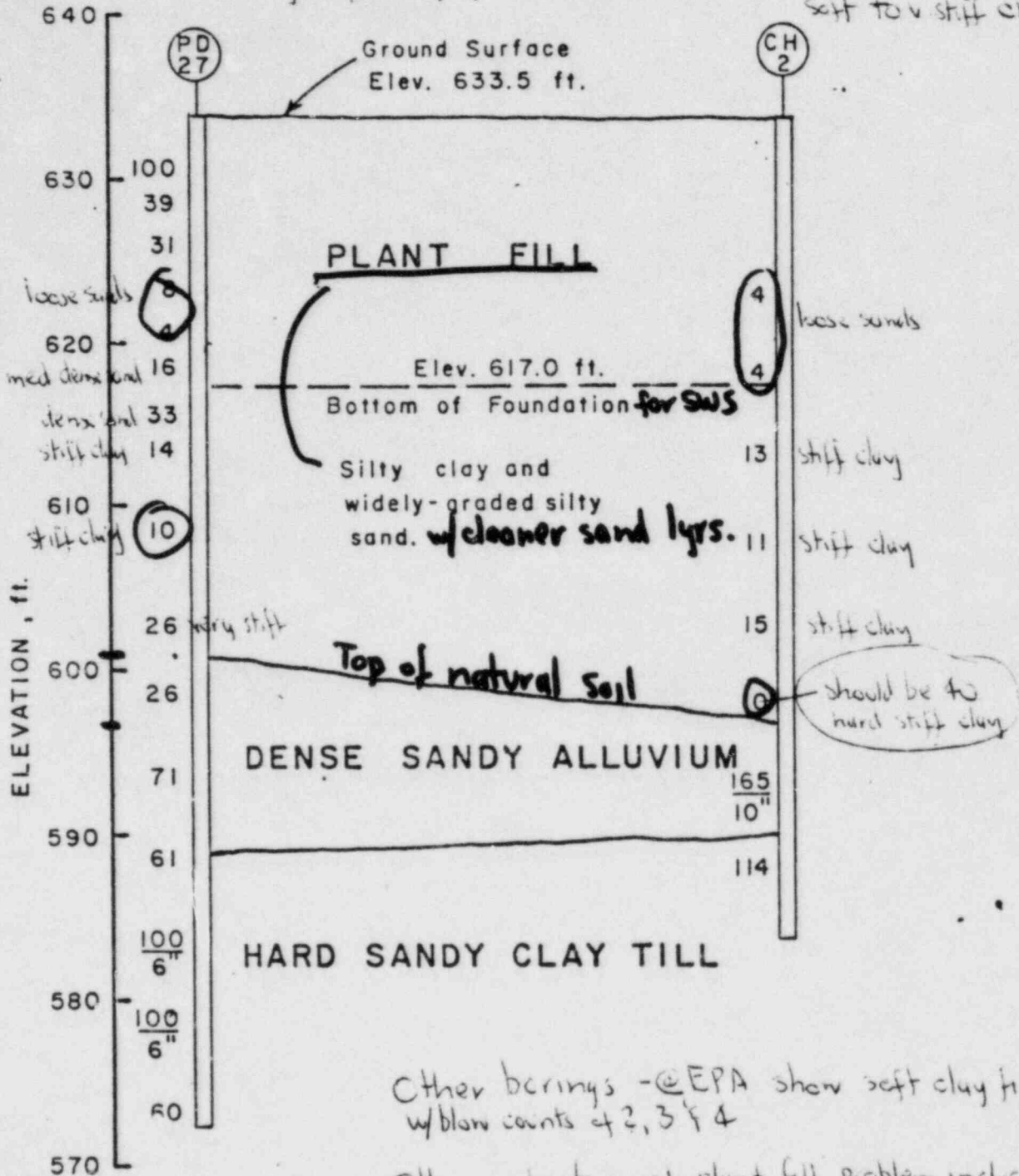
PROFILE 8"-1HBC-81

SCALE: VERT. 1" = 1'
HORIZ. 1" = 10'

Figure 4

In addition to settlement records we have results of extensive subsurface exploration program that was undertaken in late 1978 after discovery of DGB settlement problem

Borings reflect highly variable fill consistency - loose to v dense SANDS soft to v stiff CLAYS



Other borings - @EPA show soft clay fill w/ blow counts of 2, 3 & 4

Other indicators of plant fill problem include cracking of structures (e.g. BWS Ring beam fdr.), results of plate load test and re-examination of compaction control records

SIMPLIFIED SOIL PROFILE AT SERVICE WATER PUMP STRUCTURE

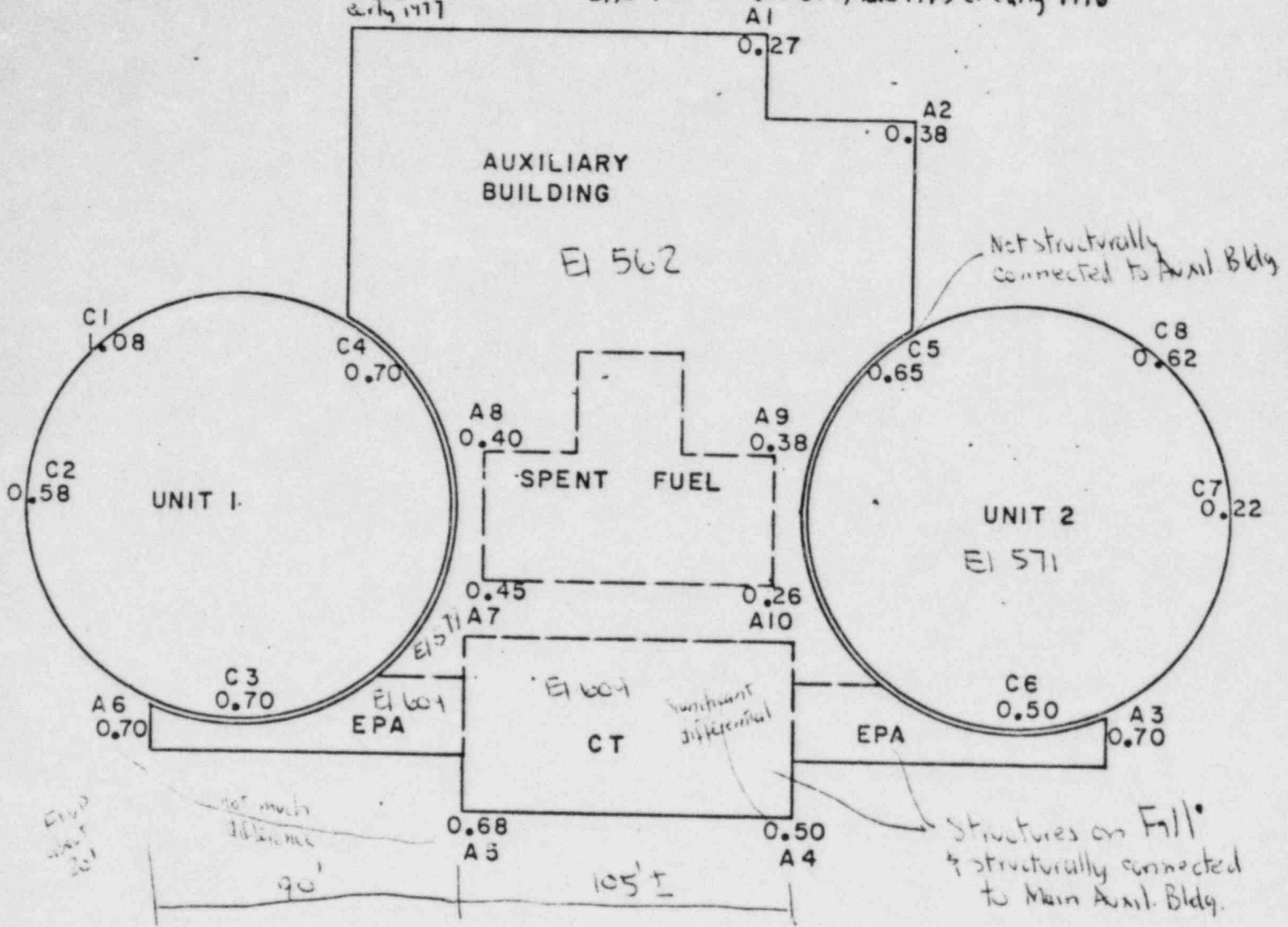
CLAYS
Soft N 2 to 4
Med 4 to 8
Stiff 8 to 15
v Stiff 15 to 30
Hard > 30

SAND
4 to 10 loose
10 to 30 medium
30 to 50 dense

GES-6

Information Provided by A. Boes via telephone on 6/22/82

Structure	Date of Earliest Settlement Reading	Date of Foundation Construction
Reactors Fig 2.5-11 & SK-G-414	mid-77 to early 78	Unit 1 Reactor - Jul 9, 1974 Unit 2 Reactor - Apr 10, 1975
AUXIL. BLDG Fig 2.5-9C SK-G-412	mostly early 78 SETTLEMENTS IN INCHES earliest was in early 1977	Main AUXIL. BLDG (Ei 562) July 1970 to Sept. 1970 EPA & RR BATH (Ei 604) late 1975 or early 1976



PLAN OF POWER BLOCK
SETTLEMENTS (FEB, 1976) THROUGH AUG., 1981

CORRECT

JULY 1978

ask Applicant to respond to settlement records in this area go back this far

Quickly summarize the affected structures
w/ identification of foundation support problems

AFFECTED SAFETY-RELATED STRUCTURES AND UTILITIES

STRUCTURE

FOUNDATION SUPPORT PROBLEM

ELECTRICAL PENETRATION
AREAS

LOOSE AND SOFT FILL LAYERS

FEEDWATER ISOLATION
VALVE PITS

LOOSE AND SOFT FILL LAYERS

CONTROL TOWER

VOID LOCATED BENEATH MUDMAT IN FILL SOILS

RAILROAD BAY

LIQUEFACTION POTENTIAL IN LOOSE FILL

AFFECTED SAFETY-RELATED STRUCTURES AND UTILITIES

STRUCTURES

DIESEL GENERATOR BUILDING

SERVICE WATER PUMP STRUCTURE

DIESEL FUEL OIL TANKS

BORATED WATER STORAGE TANKS

UNDERGROUND PIPING

FOUNDATION SUPPORT PROBLEM

EXPERIENCED LARGE SETTLEMENTS

LIQUEFACTION POTENTIAL IN LOOSE FILL

LOOSE AND SOFT FILL LAYERS

ISOLATED LAYER OF LOOSE FILL

EXPERIENCED LARGE SETTLEMENTS AND
CRACKING OF RING BEAM FOUNDATIONS.

EXPERIENCED LARGE SETTLEMENTS.

LOOSE SAND FILL LAYERS.

- Identify Structures

- Note remedial measures include:

UNDERPINNING

REMOVAL & REPLACEMENT

INSTALLATION of PERM. DEWATERING SYSTEM

SURCHARGING nearly completed STRUCTURE

for pipes REBEDMENT and REPLACEMENT

AFFECTED SAFETY-RELATED STRUCTURES AND UTILITIES

STRUCTURES

PROPOSED REMEDIAL MEASURES

ELECTRICAL PENETRATION
AREAS

UNDERPIN WITH PERMANENT CONCRETE
WALL EXTENDED TO UNDISTURBED NATURAL
SOIL.

FEEDWATER ISOLATION
VALVE PITS

REPLACE LOOSE AND SOFT FILL SOILS
WITH COMPACTED GRANULAR FILL.

CONTROL TOWER

UNDERPIN WITH PERMANENT CONCRETE
WALL EXTENDED TO UNDISTURBED NATURAL
SOIL.

RAILROAD BAY

ELIMINATE PROBLEM WITH PERMANENT
DEWATERING SYSTEM.

AFFECTED SAFETY-RELATED STRUCTURES AND UTILITIES

STRUCTURES

PROPOSED REMEDIAL MEASURES

DIESEL GENERATOR BUILDING

COMPLETED SURCHARGE PROGRAM TO CONSOLIDATE FILL AND ACCELERATE SETTLEMENT.

ELIMINATE PROBLEM WITH PERMANENT DEWATERING SYSTEM.

SERVICE WATER PUMP STRUCTURE

UNDERPIN WITH PERMANENT CONCRETE WALL EXTENDED TO UNDISTURBED NATURAL SOIL.

DIESEL FUEL OIL TANKS

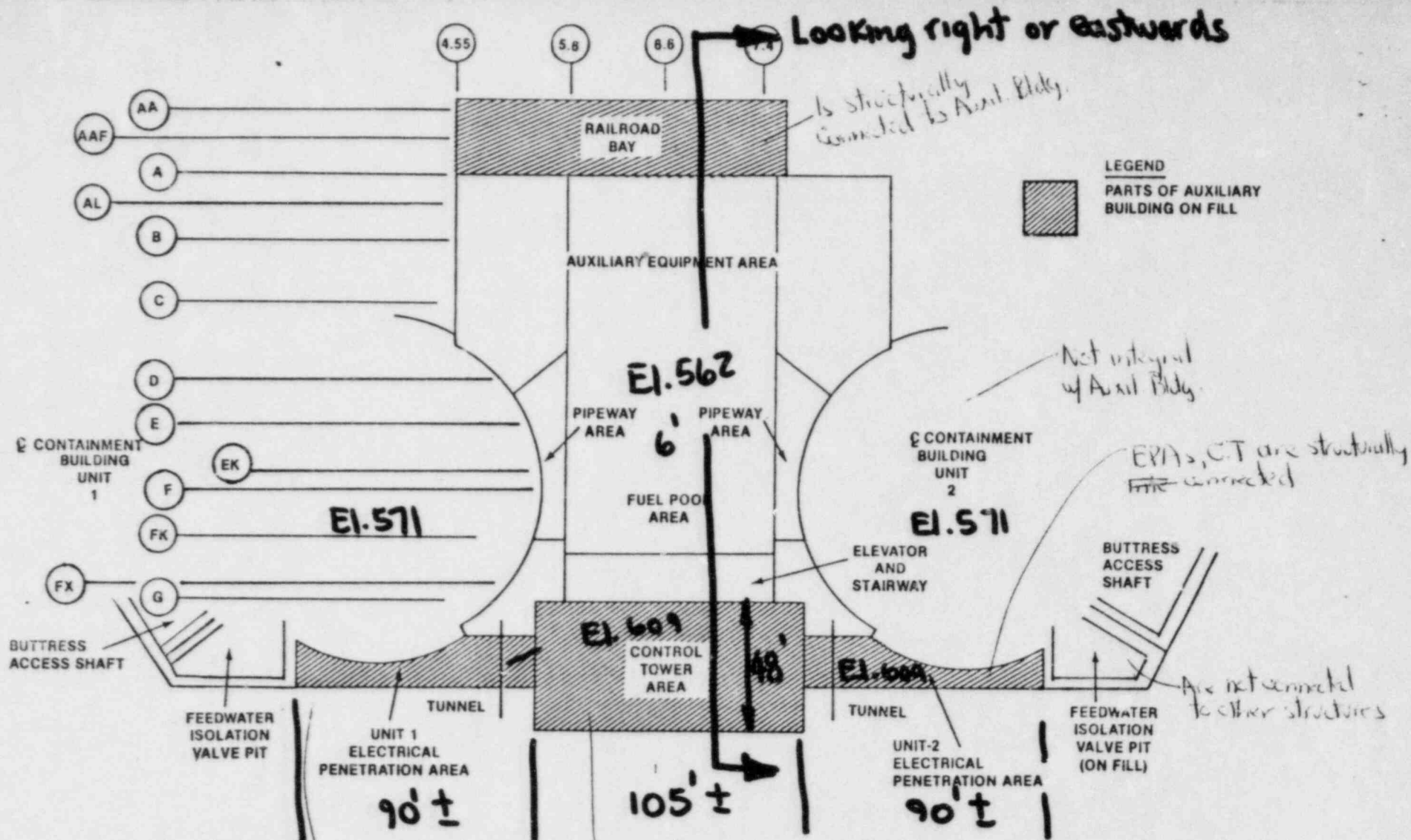
NOT REQUIRED BECAUSE OF LIMITED EXTENSION

BOILED WATER STORAGE TANKS

COMPLETED SURCHARGE PROGRAM TO CONSOLIDATE FILL. PLAN TO CONSTRUCT NEW RING BEAM FOUNDATIONS AND RELEVEL UNIT 1 TANK

UNDERGROUND PIPING

REPLACE OR REBED LENGTHS OF PIPES MOST AFFECTED BY SETTLEMENT OR LIQUEFACTION. RELY ON MONITORING DURING PLANT OPERATION FOR OTHER PIPING LENGTHS.



TURBINE BLDG
 El. 601
 (1/2)

**CONSUMERS POWER COMPANY
 MIDLAND UNITS 1 AND 2**

AUXILIARY BUILDING PLAN

FIGURE II-1 GES-52

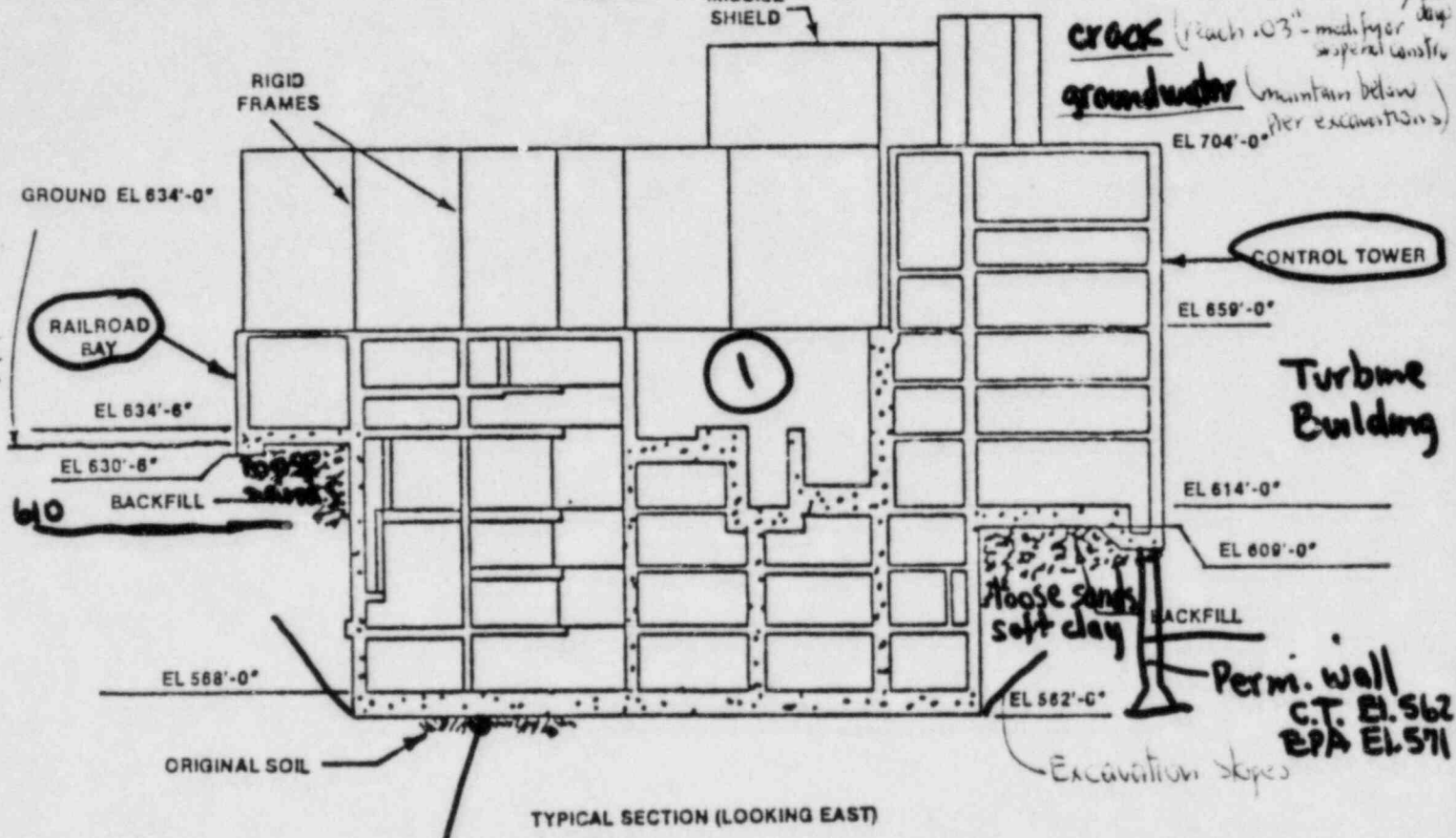
3

- Staff assessment of proposed underpinning fix:
- Provides a positive solution for eliminating foundation problem
 - EPA & C.T. loads will be transmitted to very competent foundation layer
 - Monitoring during construction will permit verification of foundation adequacy and will include:
 - check on bearing capacity (Cone penetrometer)
 - Allowable bearing pressure 6 KSF EPA
 - 8 KSF C.T.
 - 25 KSF Temp. pier base

Product - During work
2.6 EPA
0.9" C.T.

soil modulus (load test to establish clay modulus to verify long term settlement limits)

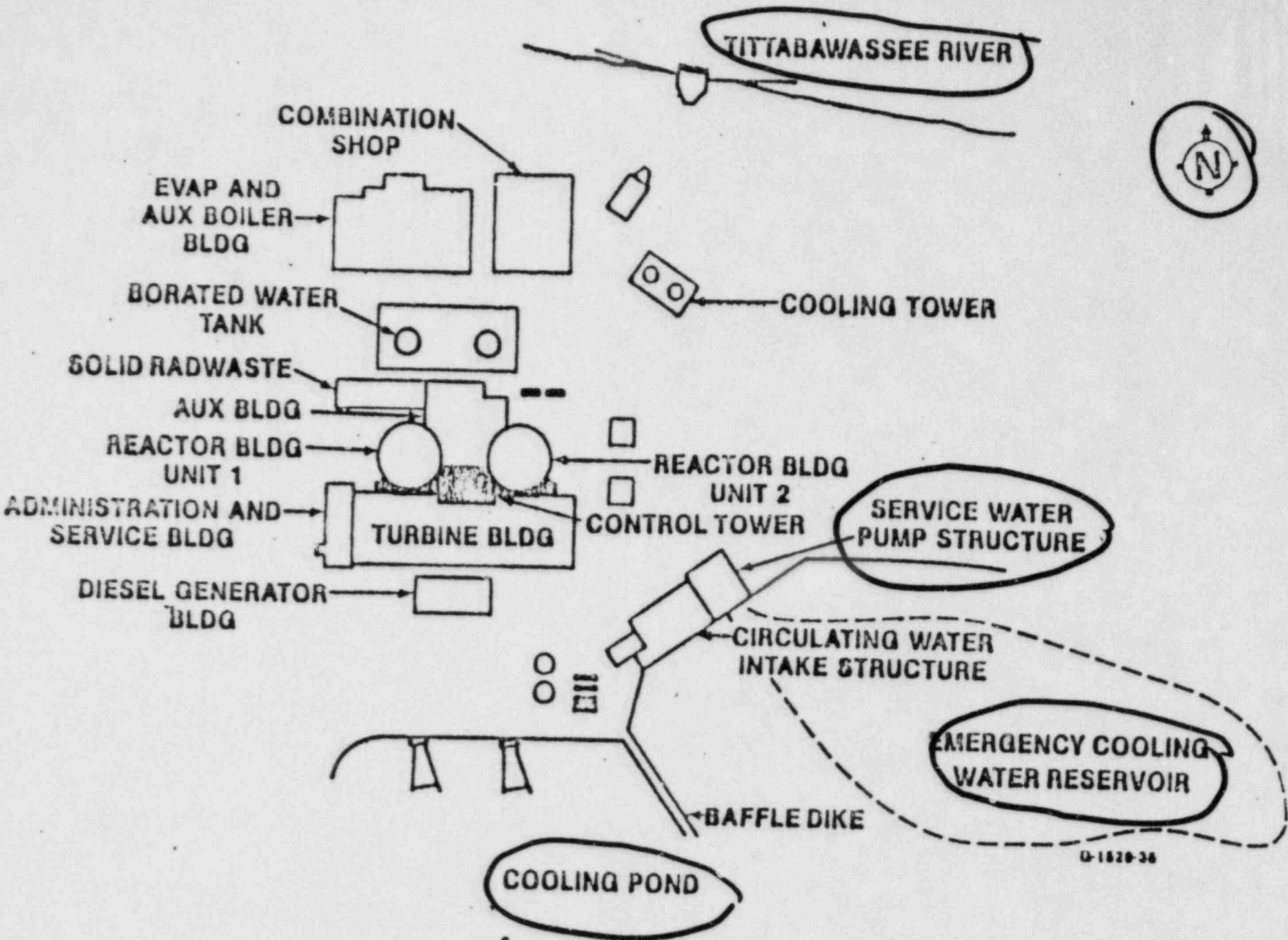
settlements (not exceed 0.05 inch last 30 days & not greater than 0.01 inch / 10 days)



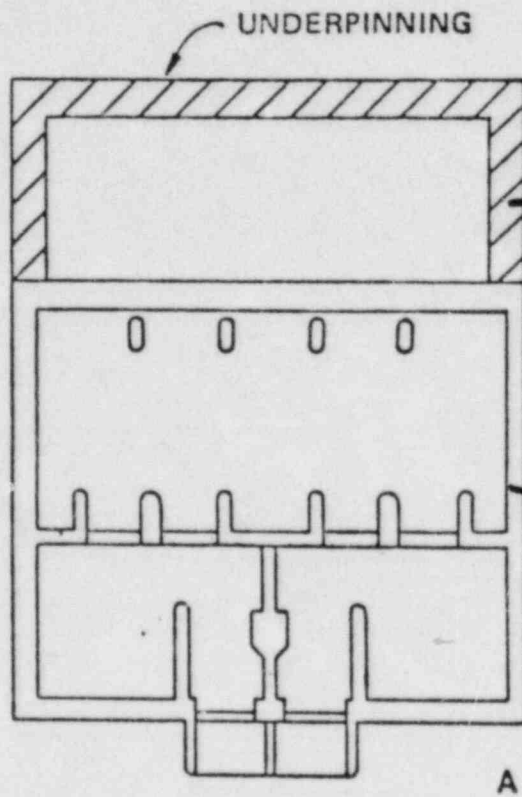
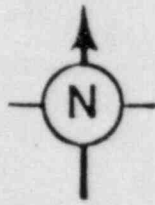
② Foundation - Very STIFF & HARD CLAY (CL)
 Median blow counts = 56 blows/ft
 LL 42, PL 20, $w_{nat} = 20\%$
 fines 90 to 98% $\delta_{total} = 130pcf$
 Median undrained strength = 7.6 KSF

AUXILIARY BUILDING SECTION

GRS-53



SITE PLAN



Note section location for next Vu-graph

Portion on fill to be underpinned

Portion on till

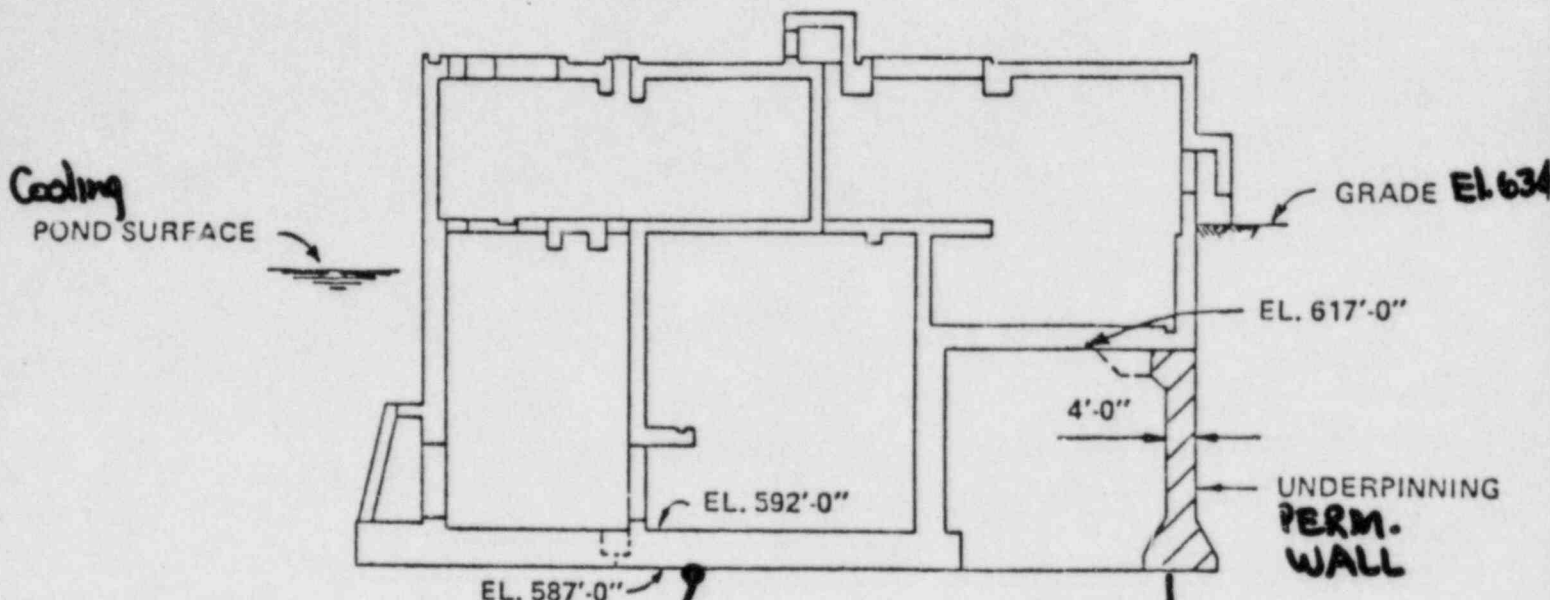
PLAN AT EL 592'-0"

UNDERPINNING GENERAL LAYOUT

GES-55

Staff assessment

- Piers will be founded on very competent foundation layer
- Positive solution will eliminate plant fill problem
- Monitoring during construction will permit verification of foundation adequacy

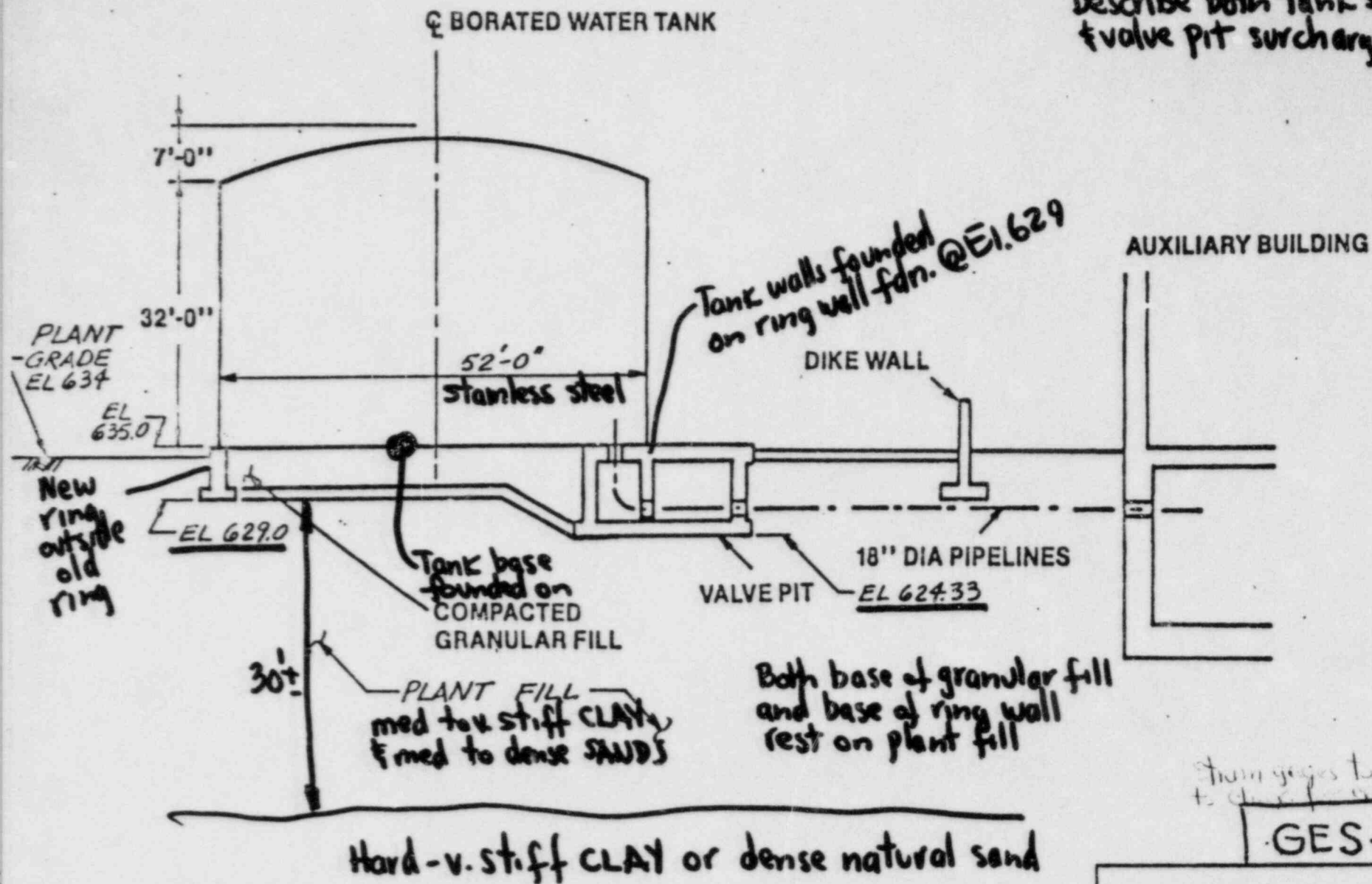


Foundation
 Hard sandy CLAY TILL
 Top Elev. \approx 590
 Median N = 75 blows/ft (50 to 120)
 LL 17, PL 11, $W_n = 9\%$ $\gamma_t = 145 \text{ pcf}$
 $\gamma_{dry} = 134 \text{ pcf}$
 fines 50 to 70%
 Adopted undrained shear strength = 8 KSF
 Heavily preconsolidated (98 tsf) $E = 6000 \text{ to } 9000 \text{ KSF}$

UNDERPINNING GENERAL LAYOUT

GES-56

Show locations - GES-54
 Describe both tank surcharge
 & valve pit surcharge programs



Staff assessment:
 The completed surcharge programs will result in tolerable future settlements which have conservatively been designed for in the NEW RING BEAM design. Settlement monitoring will permit verification of estimates

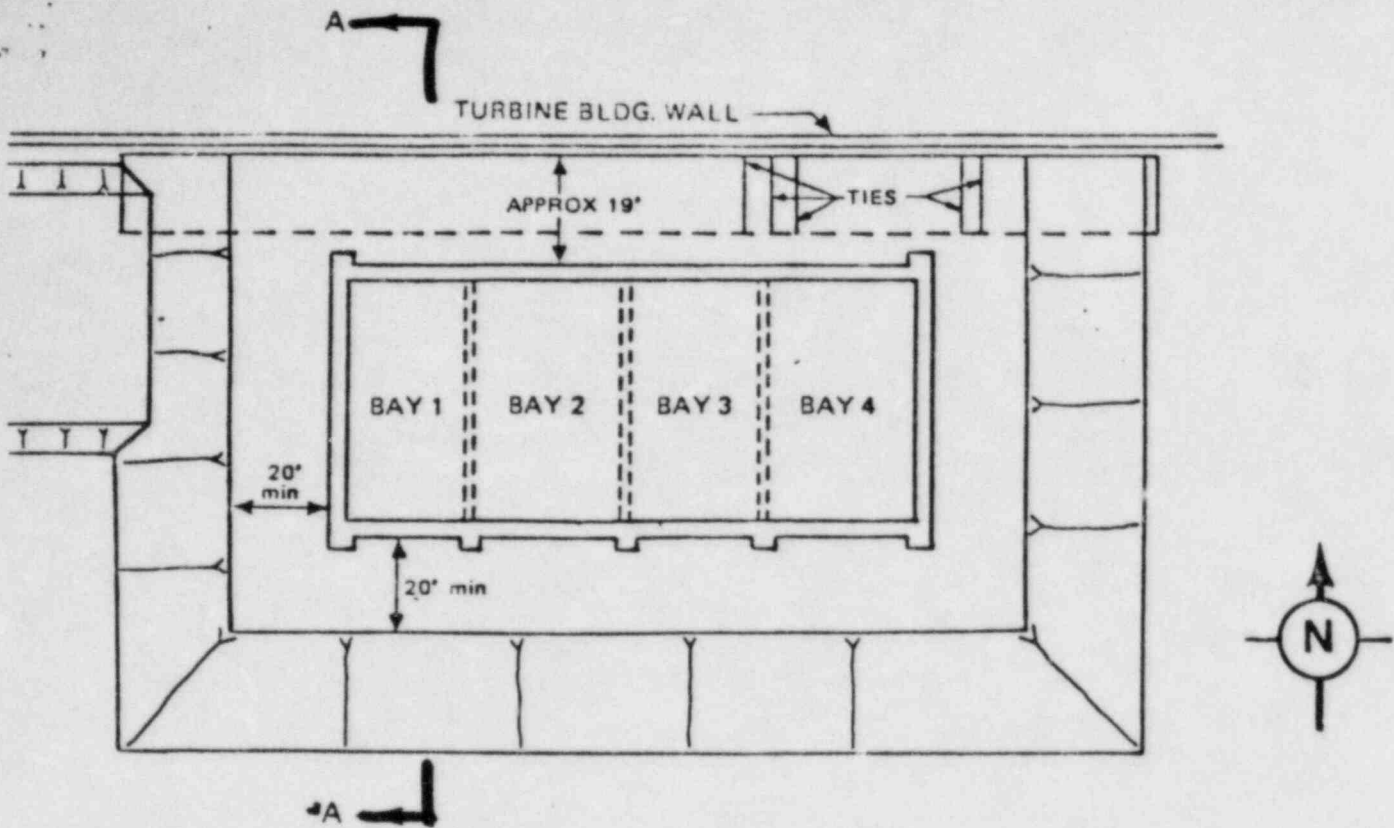
Strain gauges to be installed to check for settling

GES-57

CONSUMERS POWER COMPANY
 MIDLAND PLANT UNITS 1 & 2

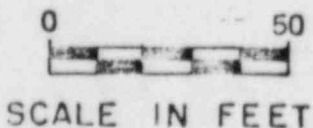
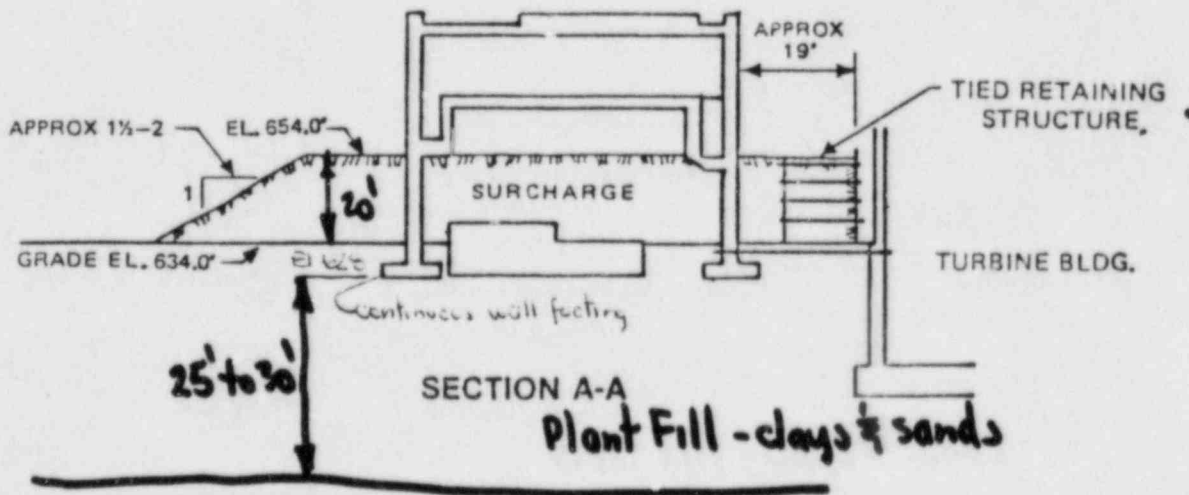
BORATED WATER STORAGE TANK
 (NO SCALE)

FIGURE 2



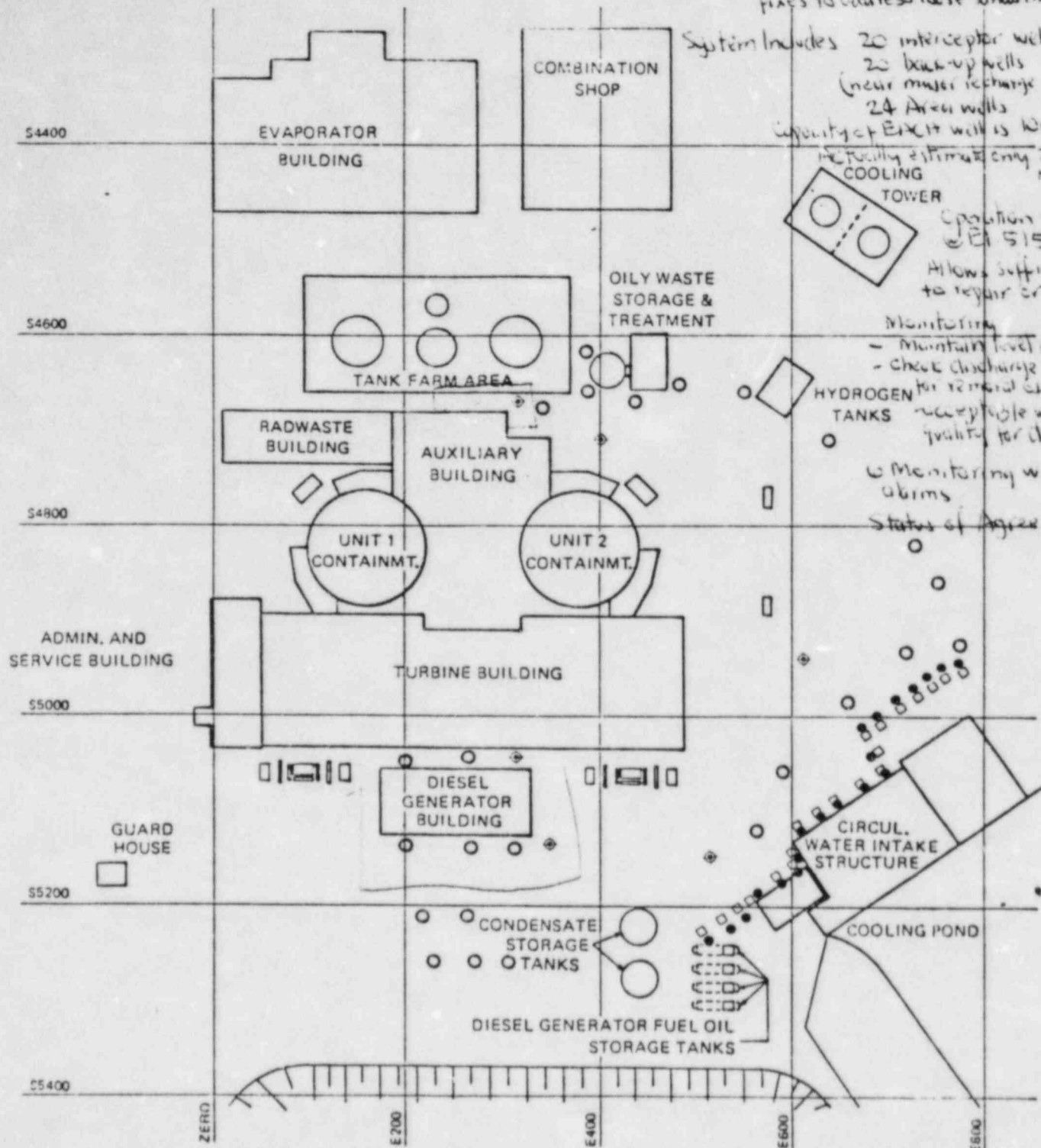
PLAN

About 60% completed when problem discovered in July 1978

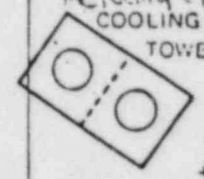


CONSUMERS POWER COMPANY MIDLAND UNITS 1 AND 2
GENERAL LAYOUT OF SURCHARGE LOAD DIESEL GENERATOR BUILDING
FIGURE I-1 GES-58

Necessary - Potentially liquefiable loose sands on plant floor
 - Other locations (EPA, SWS, piping) have plans to address loose sands in those areas

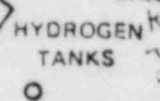


System Includes 20 Interceptor wells
 20 back-up wells (near major recharge source)
 24 Area wells
 Capacity of EXCIT well is 10gpm
 Accuracy estimate only 22 wells NEEDED



Operation - Maintain @ El 515
 Allows sufficient time to repair or shut down.

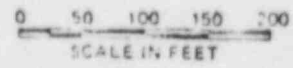
Monitoring - Maintain level @ El. 515
 - Check discharge water for removal of fines
 - acceptable water quality for discharge



Monitoring wells w/ alarms
 Status of Agreement

EXPLANATION

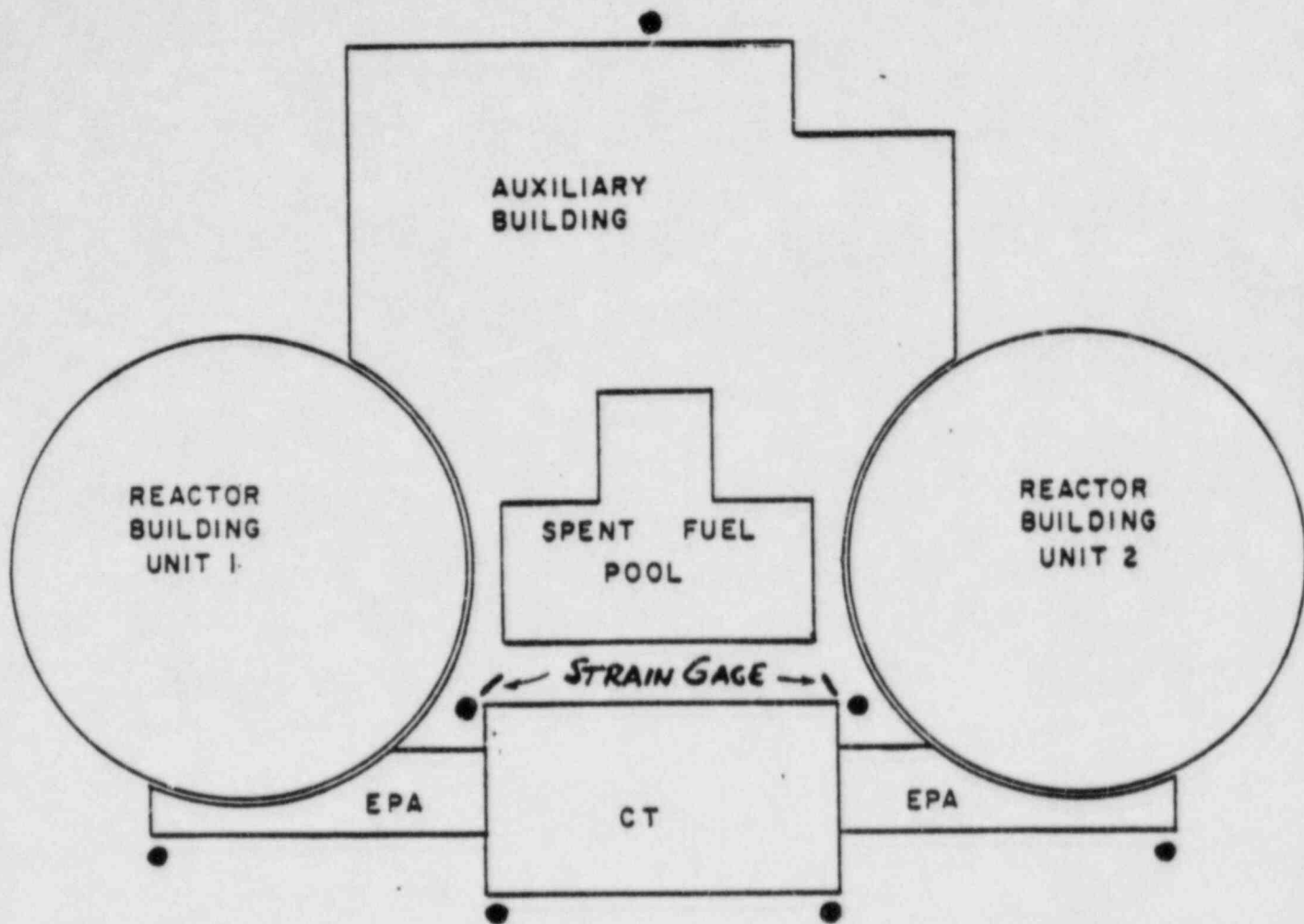
- INTERCEPTOR WELL
- BACKUP INTERCEPTOR WELL
- AREA WELL
- ⊕ MONITORING WELL



CONSUMERS POWER COMPANY MIDLAND UNITS 1 AND 2
PLAN OF PERMANENT DEWATERING SYSTEM
FIGURE V-2

GES-60

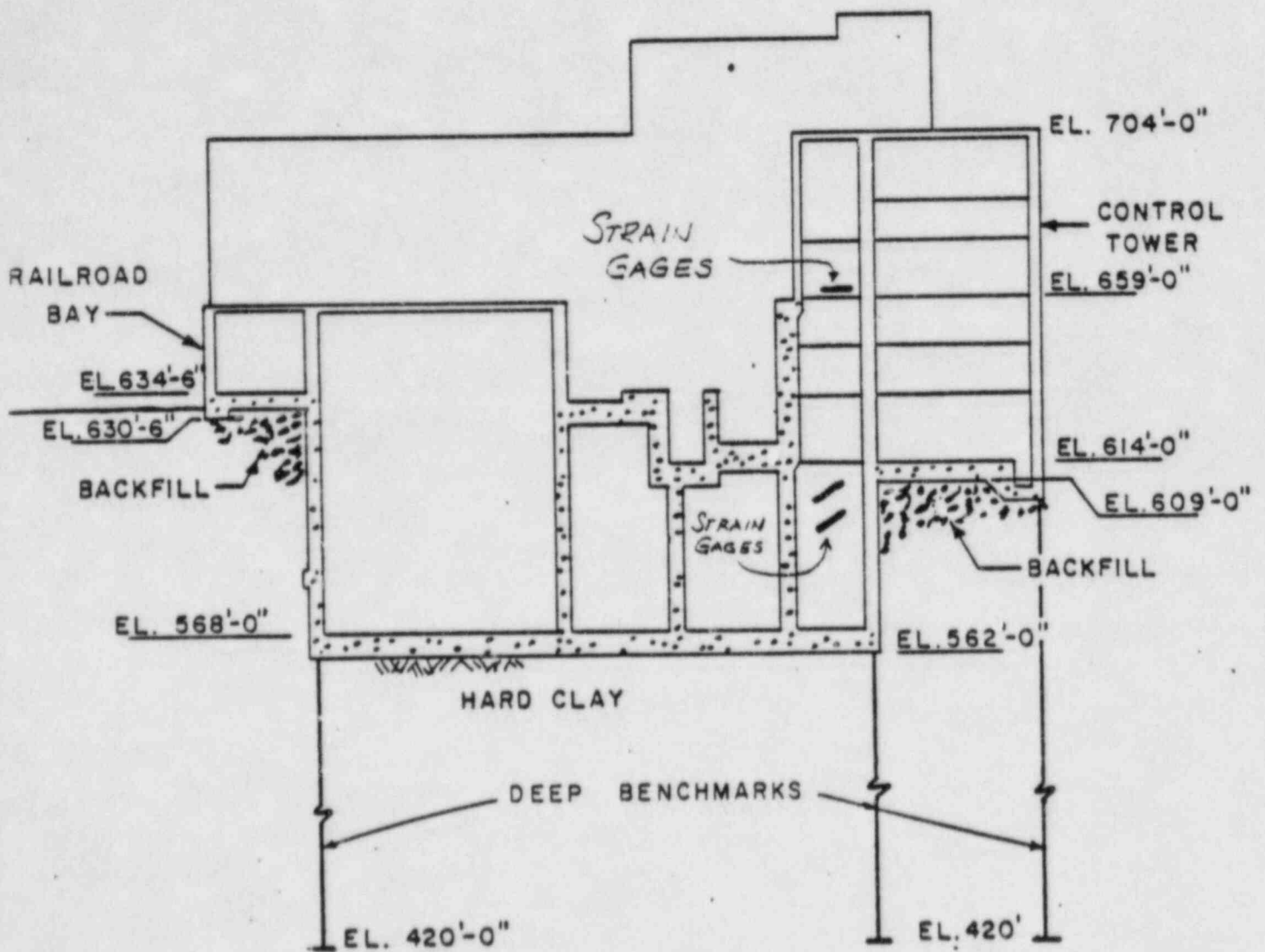
G-1046 23



● *Deep benchmarks*

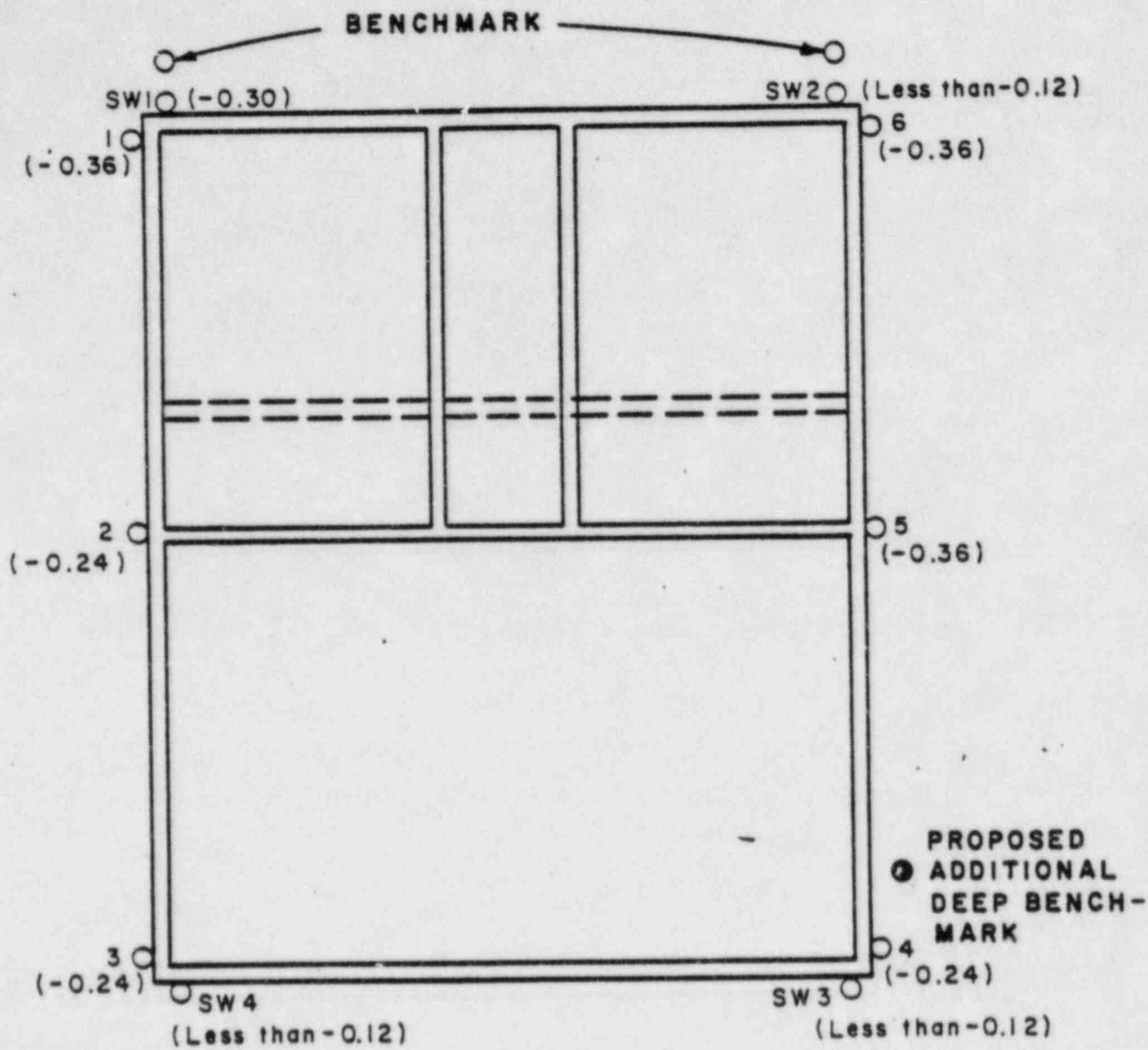
PLAN SHOWING INSTRUMENT LOCATIONS
 THAT WILL BE USED TO CONTROL
 CONSTRUCTION

GES-61



CROSS SECTION
 MAIN AUXILIARY BUILDING

GES-62



Settlements in inches

SERVICE WATER PUMP STRUCTURE

GES-63