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GOVERNMENT OF ONTARIO
Ministry of Transportation
and Communications
Downsview, Ontario

THOROLD TUNNEL

INSPECTION OF ROCK SLOT
SOUTH OF WEST SERVICE BUILDING

September 1982

Acres Consulting Services Limited
Niagara Falls, Canada

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PLATE (in pocket at back of report)

1 - INTRODUCTION

While studying a seepage problem adjacent to the west portal of the Thorold Tunnel in 1979, various areas and potential sources of water were investigated. One of these was the rock squeeze pressure relief slot which had been excavated in 1973 - 1974 on the south side of the west service building. A cursory inspection of the slot, where it is exposed in two manholes, indicated that the surface of the slot fill material (a clay/bentonite mixture) was below the bedrock surface. In Acres Consulting Services Limited (Acres) report on the seepage control works dated September 1979, it was recommended that the manholes be pumped out and the slot conditions carefully checked to ensure that the slot fill and piping barriers are performing in the manner for which they were intended. A general arrangement of the slot and manholes is shown on Plate 1.

In August 1982, the Ministry of Transportation and Communications (MTC) authorized Acres to undertake the slot inspection under Agreement No. 4242-9082-124. The terms of reference for the study were defined as follows, "Inspect the "Rock Slot" at the Thorold Tunnel, determine the condition and efficiency of the bentonite seal and prepare a report detailing findings and containing recommendations for remedial action."

An inspection of the slot was undertaken by Acres' personnel, the results of which are outlined herein together with recommendations. In addition to the work related to the slot, the rate of flow into the west sump and the condition of rock instrumentation in the vicinity of the slot were checked. The findings from this work are also included in this report.

2 - FIELD INVESTIGATION WORK AND OBSERVATIONS

The field work related to the slot inspection was undertaken primarily between August 31 and September 2, 1982 and included the following items.

2.1 - Survey Elevations

Using the main floor of the west service building as a benchmark (el 588.50 ft), elevations at and in the two manholes were determined as follows.

	<u>East Manhole</u> (ft)	<u>West Manhole</u> (ft)
Cover el	587.62	587.44
Water el	566.97	563.80
Bedrock el	563.82	563.80

By way of reference, the water level in the Welland Canal is approximately 569.0±.

2.2 - Brass Bolts (West Manhole)

In December 1976, two brass bolts were set in the bedrock surface on each side of the slot in the west manhole for the purpose of measuring rock surface movements. At the time of

installation the near-faces of the bolts were 10.48 in. apart. During this inspection program the bolt faces were 10.19 in. apart indicating a relative movement of the surface rock of 0.29 in. since 1976.

2.3 - Dewatering of East Manhole

The water in the east manhole was drawn down from el 566.97 to el 564.12 in 13 minutes using a 2 in. submersible Flygt pump. This represents an average pumping rate of approximately 17 gal/min.

On completion of the slot inspection, the water level recovery was noted and it was found that the rate of inflow into the manhole was quite low and of the order of 3 gal/h.

2.4 - Inspection of Slot Fill

The probing within the slot was carried out using a metal fish wire which was pushed along the slot until an obstruction was encountered. Details of what was found in each manhole area are shown on Plate 1, Detail 1 representing the west manhole and Detail 2 the east manhole.

In the west manhole, three wooden bulkheads were encountered, one in the centre, to which instrumentation tubes had been

fastened, and two others under the manhole walls. The west bulkhead prevented insertion of the fish line, however it was possible to insert the fish over the bulkhead on the east side and extend it for 13.6 ft. Clay/bentonite adhering to the fish indicated that the slot was full on the east side. Within the manhole area, the slot fill was about 1 ft below the bedrock surface in the western half and about 2 ft down in the eastern half.

In the eastern manhole, only one wooden bulkhead was found near the manhole centre and it also had instrumentation tubes attached to it. The slot is full of clay/bentonite on the west side of the bulkhead, while a triangular-shaped void about 2 ft deep and 5 ft long exists on the east side (see Detail 2, Plate 1).

2.5 - Flow in Slot

It was of significant interest to know whether any water flow exists along the slot. Visual observations of the water in the slot did not reveal any signs of flow.

To investigate this matter further, a Kent Miniflo Type 265 flow meter was inserted in the water below each manhole and no flow was detected. Finally, a dye sample consisting of 4 ounces of Rhodamine B-500 indicator dye was placed in the

water in the east manhole on September 2. Twenty-one days later on September 23, the water in the slot below each manhole was checked for color. Water in the east manhole was pink while there were no traces of color in the west manhole.

2.6 - Instrumentation Tubes in Slot

The instrumentation tubing in each manhole was checked for identification markers, however none was observed.

In the east manhole, 3 pairs of tubing exit from the slot, however 2 pairs appear to have been damaged and discarded. The other pair were tied up to the top ladder rung. In the west manhole, 3 pairs of tubing extend up to the top ladder rung.

Because of the lack of identification tags and the inability to locate the readout equipment, reading of these instruments was not carried out.

2.7 - Flow into the West Sump

The maintenance staff have arranged to take readings of the time for water to rise in the west sump. They record the time required for the water to rise between depths of 8.60 ft

and 4.7 ft or a height of 3.90 ft. On August 27, 1982 the time was 9 minutes and 4 seconds while the range of readings for the month of August varied between 9 minutes and 0 seconds and 9 minutes and 24 seconds. A time of 9 minutes and 39 seconds was measured on September 24, 1982.

The volume of water in the 3.90 ft depth of sump is
 $70.5 \times 13 \times 3.90 \times 6.24 = 22\,300 \text{ gal.}$

The current range of inflow rate = 2,310 to 2,480 gal/min.

The comparable range of flow rate measured in 1979 was 2,125 to 2,235 gal/min.

2.8 - Extensometers Through Tunnel Wall

A brief inspection was undertaken to assess whether any of the extensometers which had been installed through the tunnel wall and into the slot area were still in operating condition. It appeared that all of the instruments were either badly calcified or had been grouted over.

3 - CONCLUSIONS

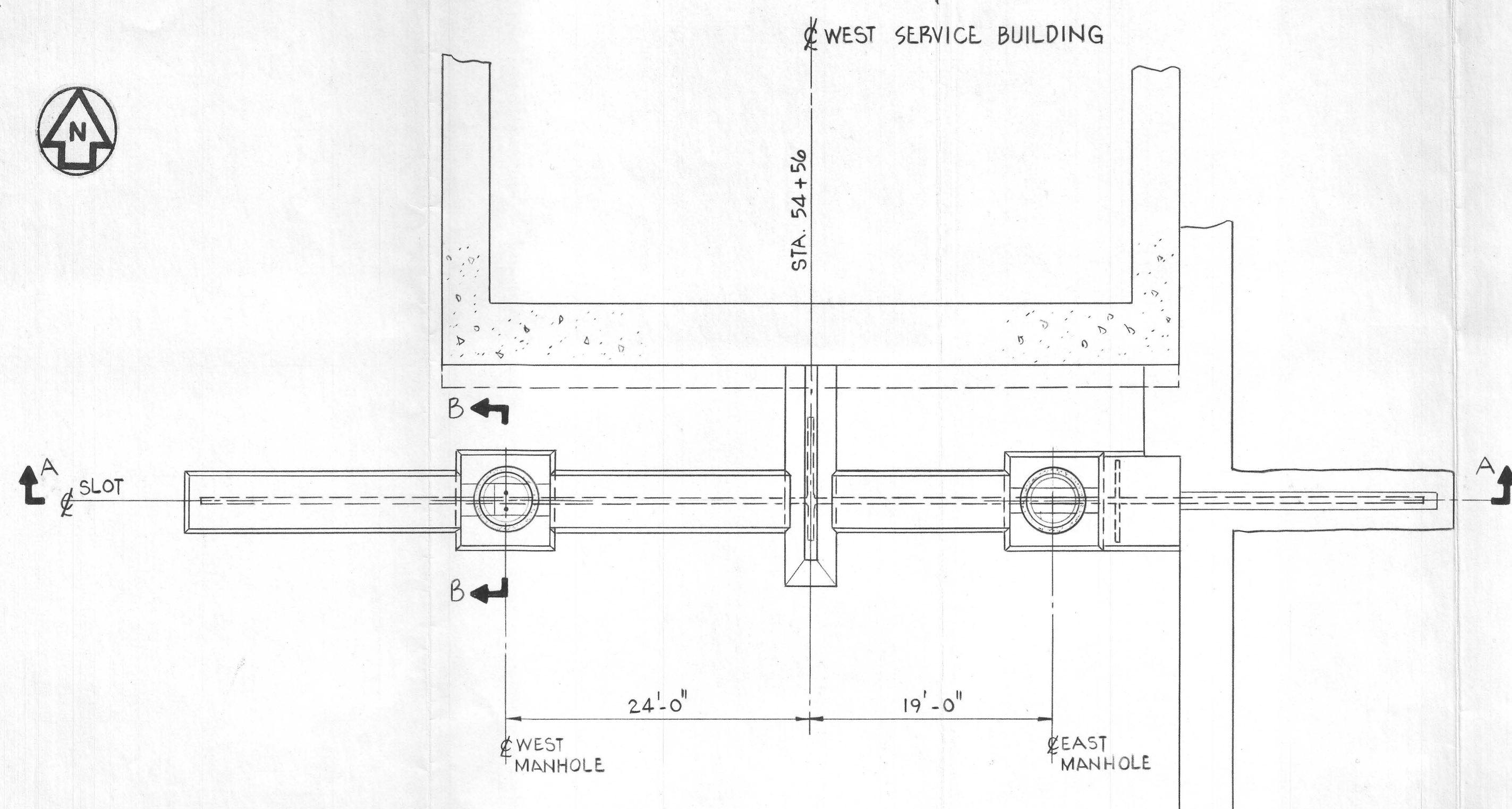
- (a) Rock movement and slot closure are taking place as evidenced by the movements of the brass bolts in the west manhole where the reduction in distance between the bolt faces has been 0.29 in. over a period of approximately 6 years.
- (b) The lowering of the surface of the slot fill material appears to have occurred only locally at the two manholes as shown on Plate 1.
- (c) No water flow appears to be taking place along the slot indicating that the seepage control barriers across the slot and the slot fill material are performing effectively.
- (d) Much of the existing instrumentation in and across the slot appears to be no longer serviceable. A more detailed inspection of these instruments would be required to assess which instruments are or could be made operable.
- (e) The rate of flow into the west sump during August and September ranged from 2,310 to 2,480 gal/min as compared to 2,125 to 2,235 gal/min in 1979. This indicates a

flow rate increase of approximately 10 percent over the
3-yr period.

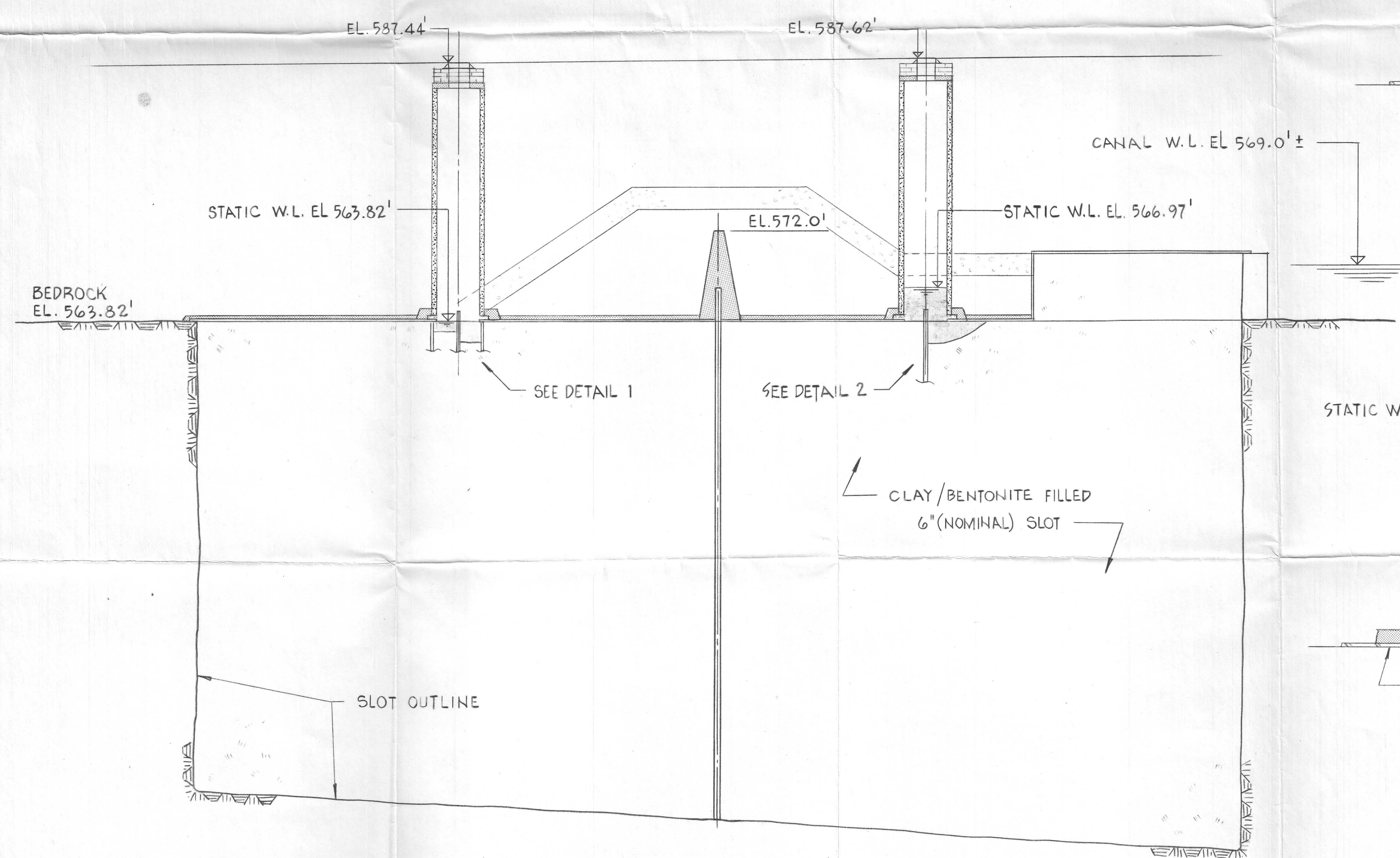
4 - RECOMMENDATIONS

Since the portion of the slot without fill material is relatively small and no flow appears to be occurring along the slot, it is not considered necessary to proceed with filling the voids at this time. It is recommended that the slot be inspected in the future, say 5 years from now, to assess whether any changes have occurred.

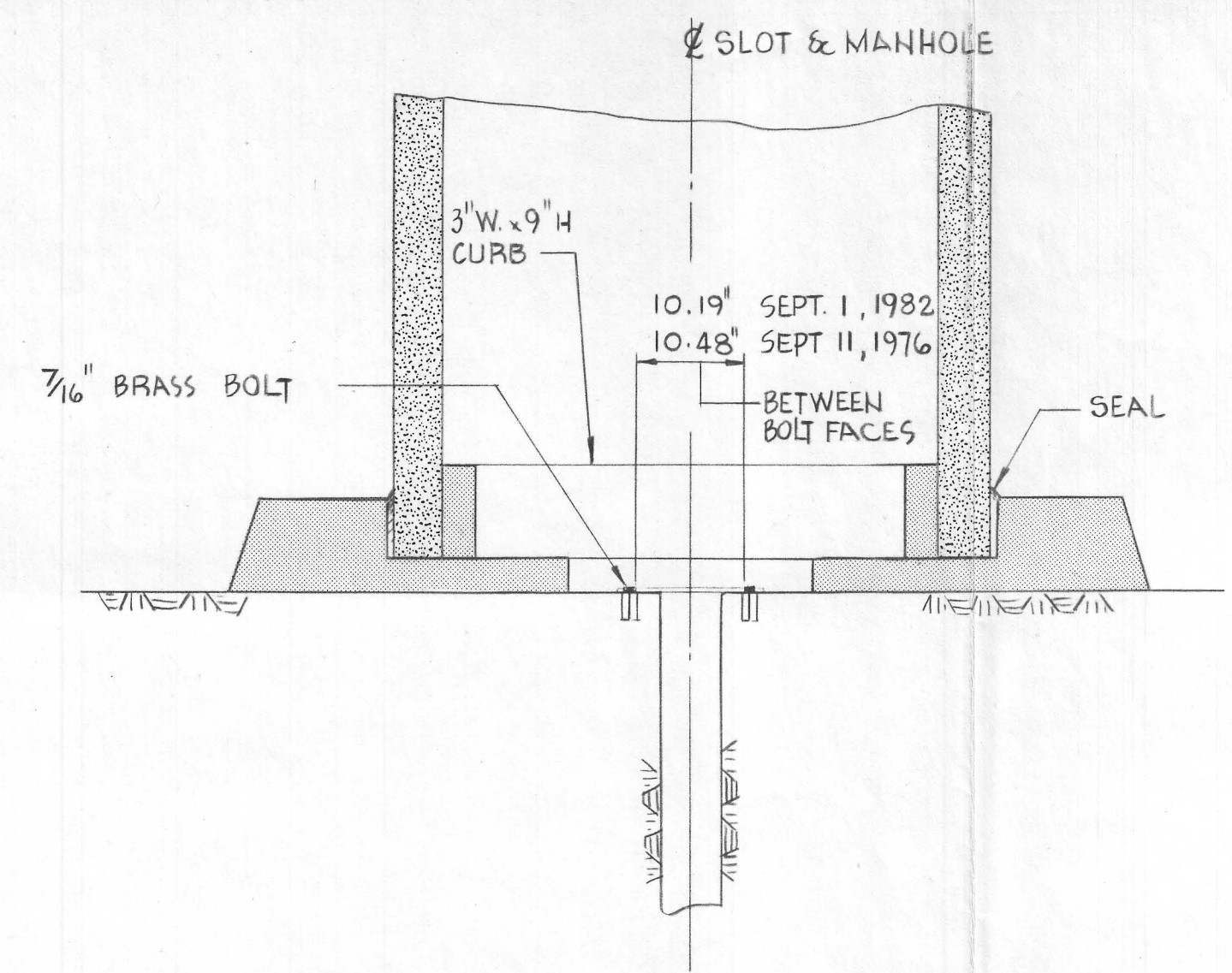
There appears to be an increase in the flow into the west sump of the order of 10 percent over the past 3 years. It is recommended that the MTC flow records be reviewed to see if this does represent a true flow increase or whether it may have been caused by changes in precipitation or variations in the methods of taking the flow measurements. It is further recommended that the flow measurements be continued on a regular basis.



PLAN
SCALE 1/8" = 1'-0"

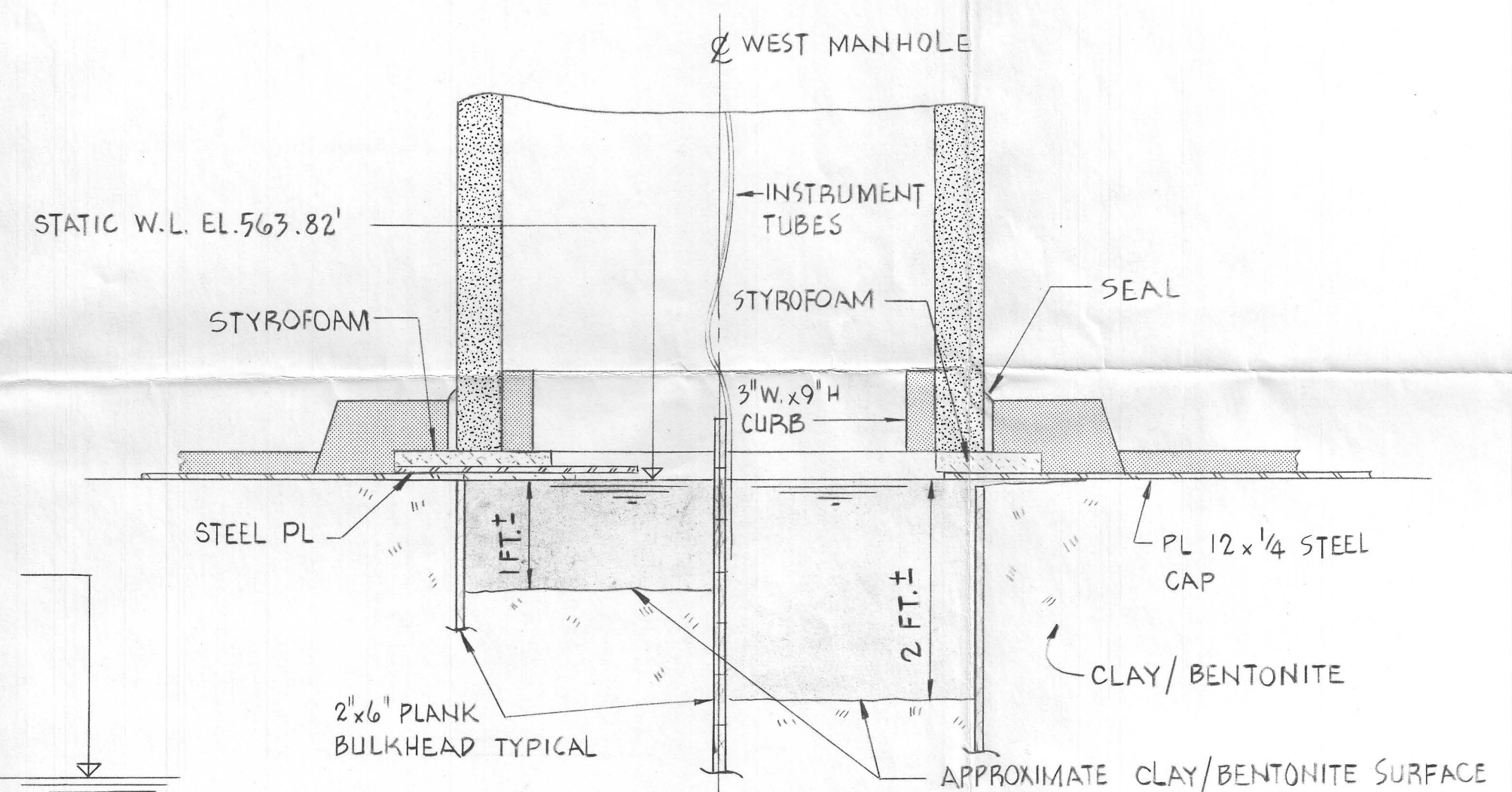


SECTION A-A
SCALE 1/8" = 1'-0"

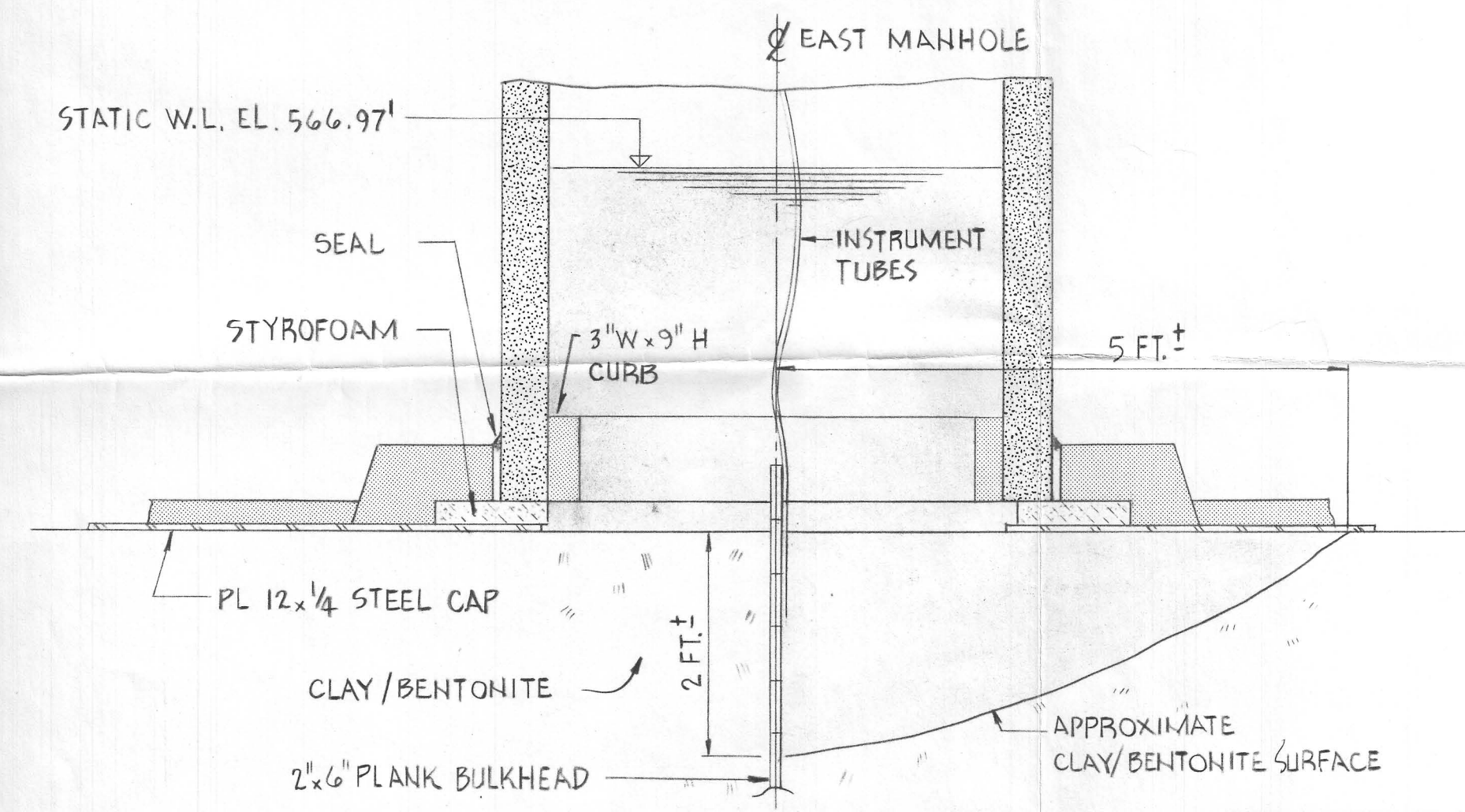


SECTION B-B
SCALE 3/4" = 1'-0"

NOTE
BENCH MARK - GROUND FLOOR OF WEST
SERVICE BUILDING WITH
ASSUMED ELEV. 588.50'



DETAIL 1
SCALE 3/4" = 1'-0"



DETAIL 2
SCALE 3/4" = 1'-0"

DATE	No.	REVISIONS	CH.	APP.	APP.

ACRS	MINISTRY OF TRANSPORTATION & COMMUNICATIONS		
	THOROLD TUNNEL - ROCK SLOT INSPECTION		
DETAILS OF SLOT FILL AND MANHOLES		DATE SEPT. 24, 1982	SCALE AS NOTED
PROJECT		DEPARTMENT HEM	DRAWING No.
PROJECT		PROJECT	PLATE 1
PROJECT		PROJECT	SHEET OF

DRAWING No. PLATE 1 REV. 0
SHEET OF
PROJECT - P 6641