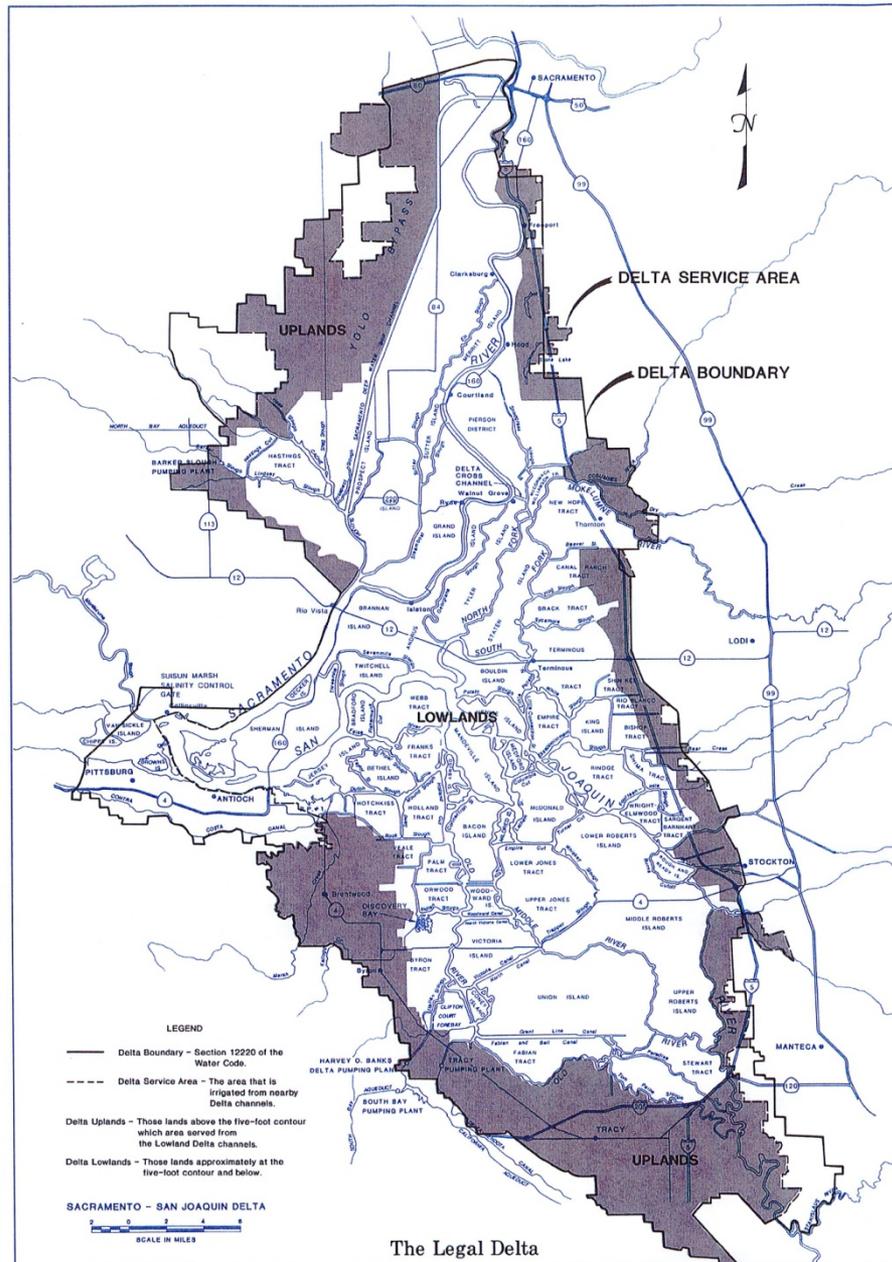


SEISMIC CONCERNS FOR LEVEES IN CENTRAL DELTA

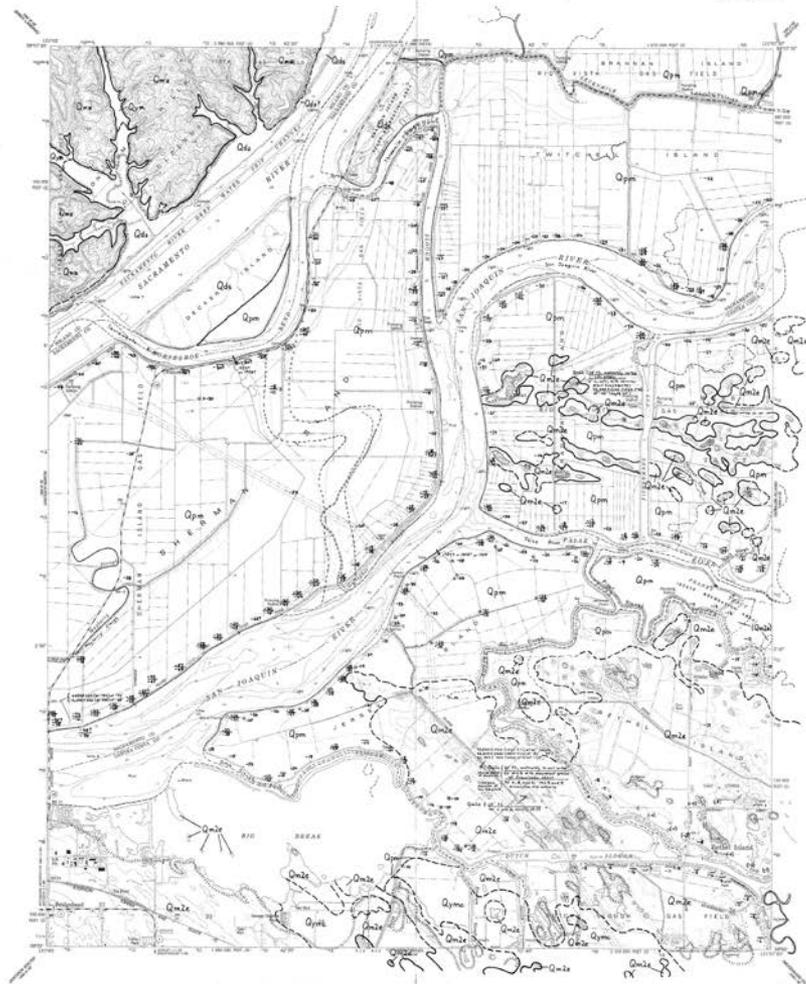
By

R. Kevin Tillis
Hultgren-Tillis Engineers



Construction History and Geology

- Constructed with local materials
- Raised due to settlement – compression of peat
- Extensive rehabilitation program since 1980's



Base from U.S. Geological Survey, 1978

Geologic map of 1978-1981

See sheet 21 and surrounding sheets for topographic and historical data.

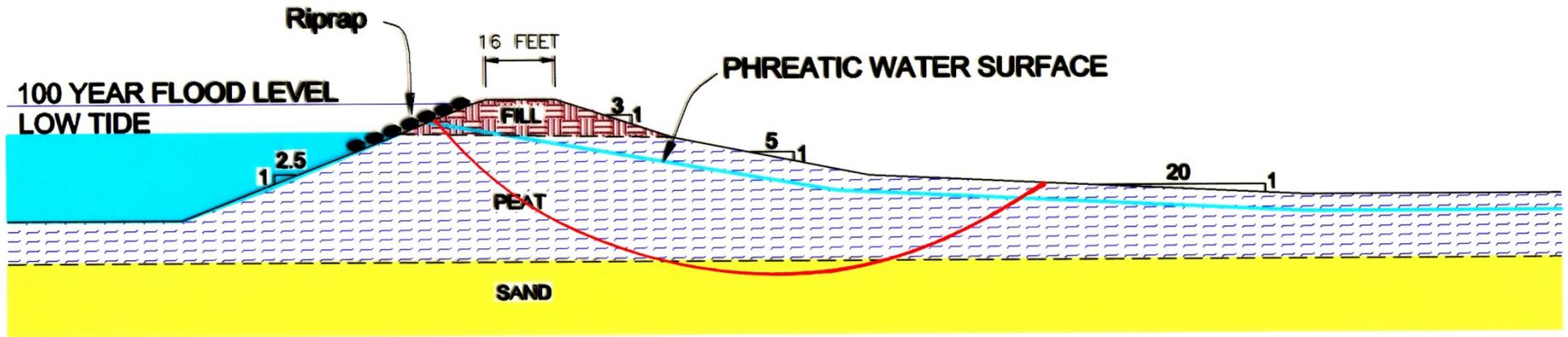
JERSEY ISLAND

GEOLOGIC MAPS OF THE SACRAMENTO-SAN JOAQUIN DELTA, CALIFORNIA

By
Brian F. Atwater
1982

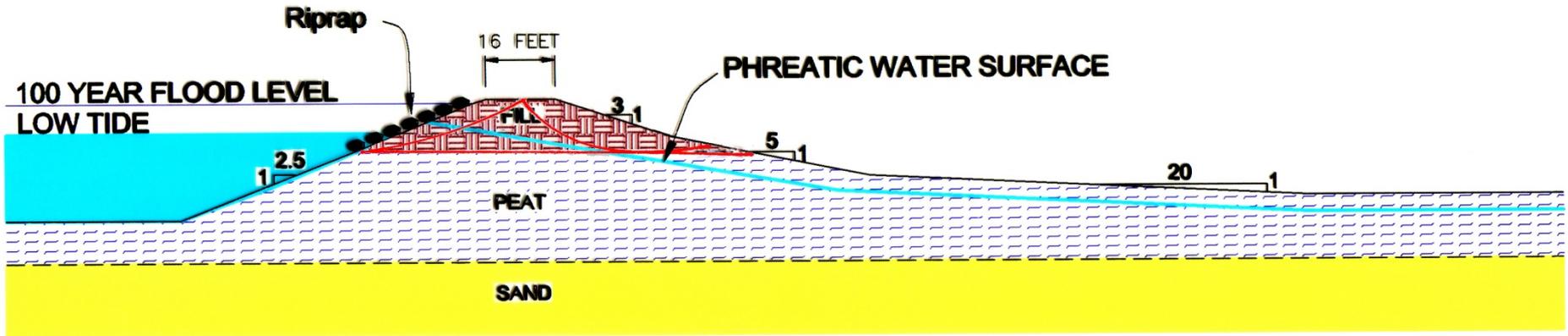
- Levee function is to hold water
- Failure: either water overtops the levee or water flows through or below the levee
- Main seismic concerns are deformation from shaking and soil liquefaction

Liquefaction of Sand

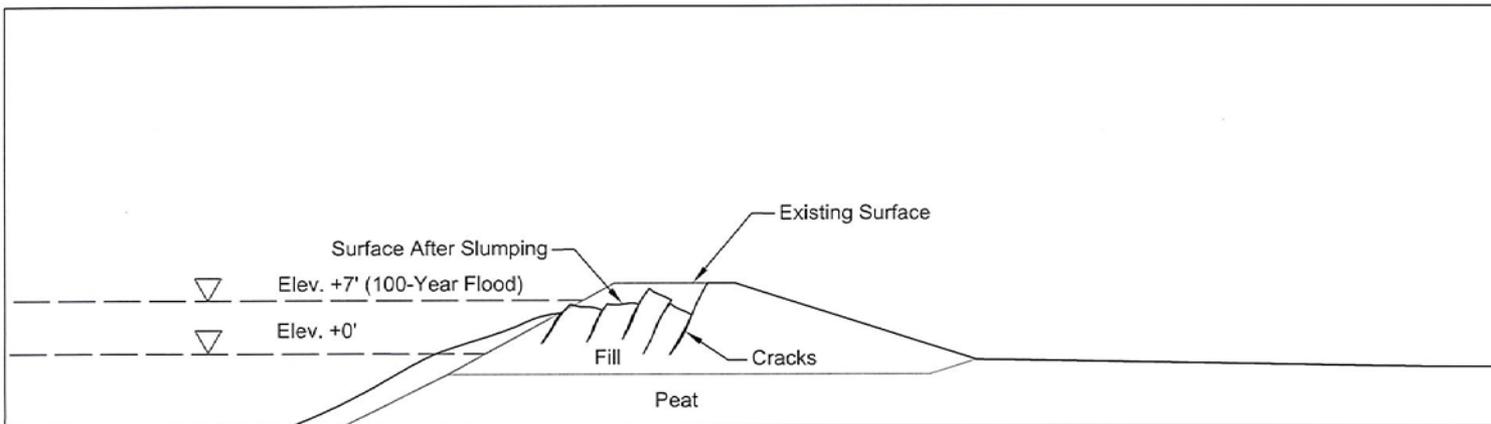


TYPICAL DELTA LEVEE

Liquefaction of Fill



TYPICAL DELTA LEVEE



Sand

- Notes: (1) Figure intends to represent movement of levee due to liquefaction of fill.
 (2) Slope deformation from liquefaction could occur toward the slough, toward the island interior or both. Only deformation toward the slough is shown on this sketch.
 (3) Even if slumping due to liquefaction does not damage the full width of the levee crest, increase seepage and piping leading to a levee breach become much more likely.
 (4) Figure is not based on detailed analysis and final shape of levee should be considered as conceptual.

SCALE



1 inch = 20 feet

Levee Assessment and Conceptual Design
 Bethel Island, California

Typical Levee
 Schematic - Post Liquefaction

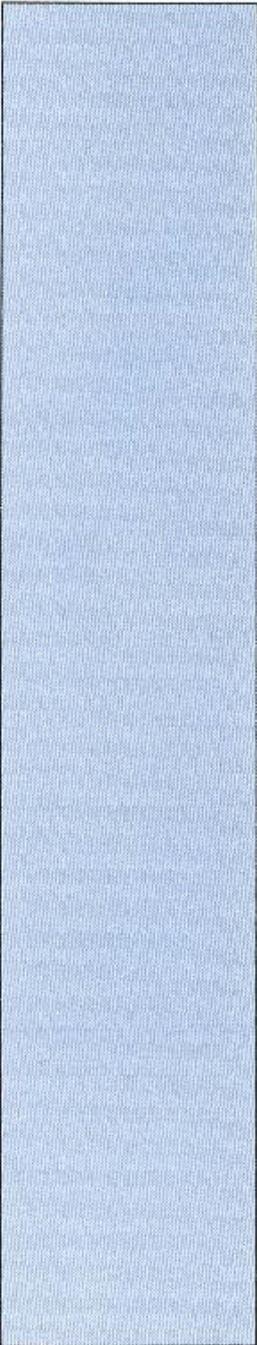
Hultgren - Tillis Engineers

Project No. 156.14

Plate No. 10

Conclusions for Seismic

- Liquefaction in the existing fills is the primary seismic risk
- Deformation from static loads are high and often exceed the calculated deformation from earthquakes
- A concern with seismic shaking and deformation is cracking and post earthquake seepage



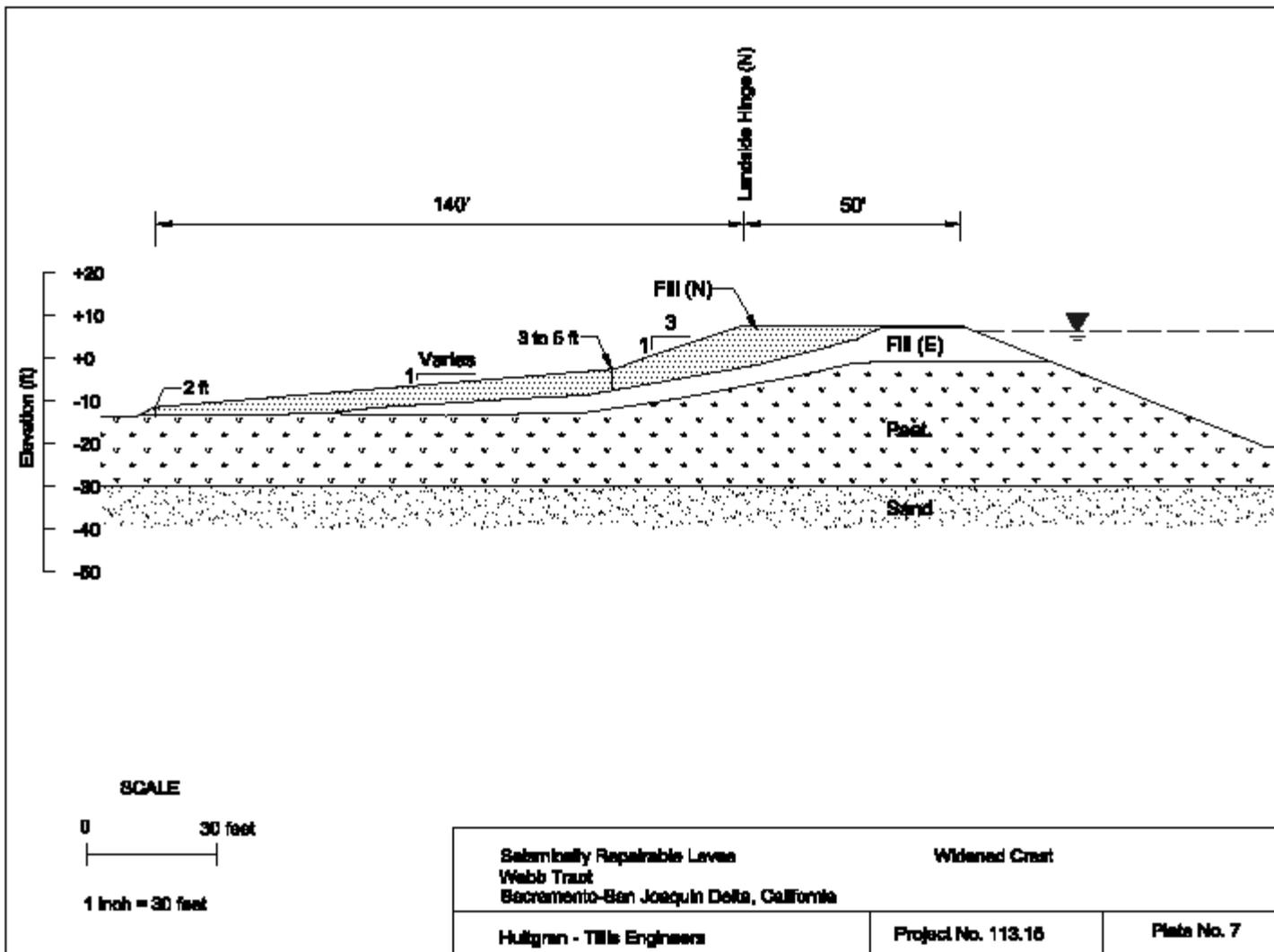
GEOTECHNICAL EVALUATION

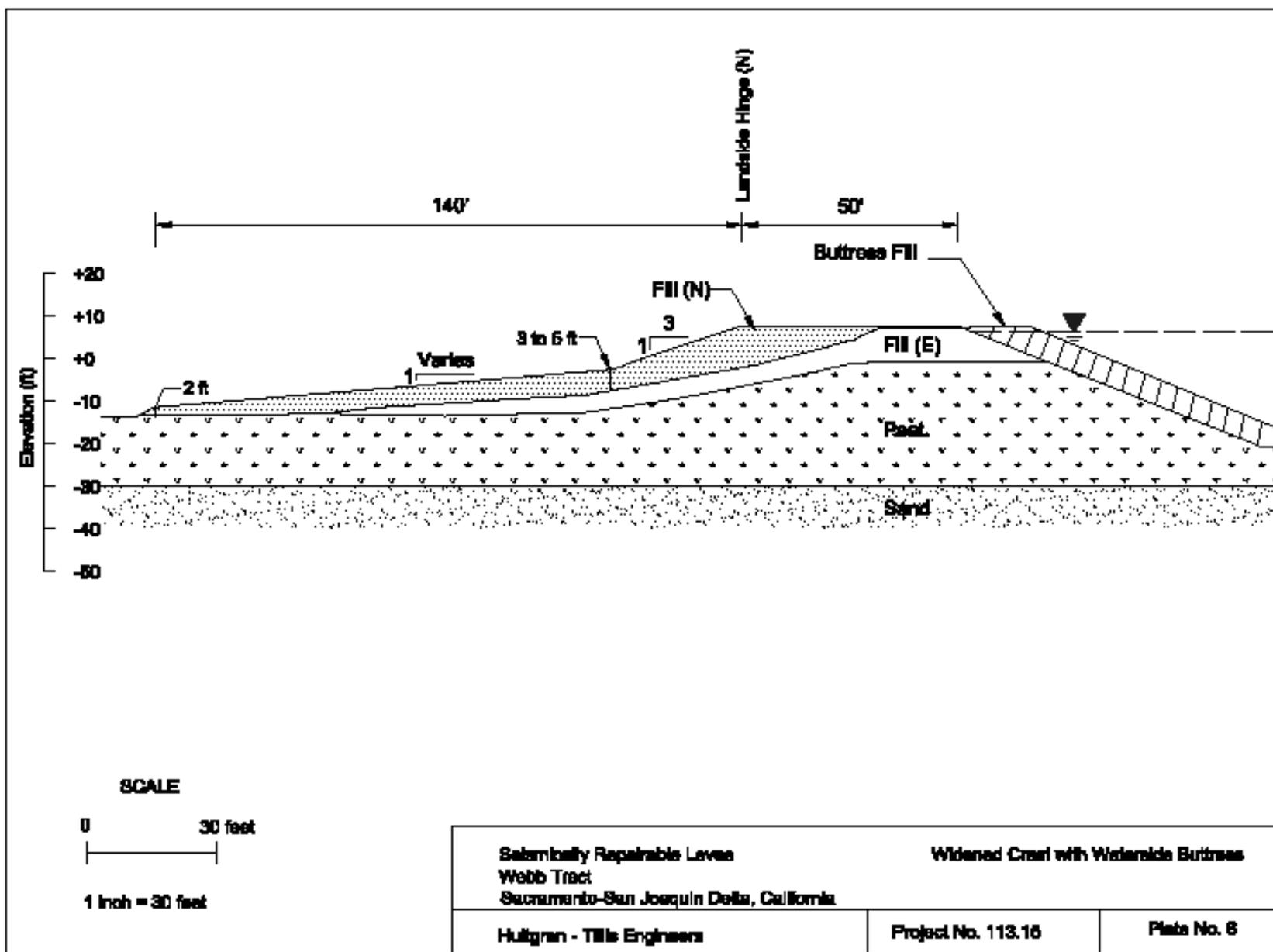
**SEISMICALLY REPAIRABLE LEVEE
WEBB TRACT
SACRAMENTO-SAN JOAQUIN DELTA, CALIFORNIA**

Project No. 113.15
December 30, 2009

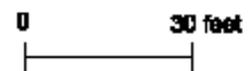
Prepared by

Hultgren – Tillis Engineers



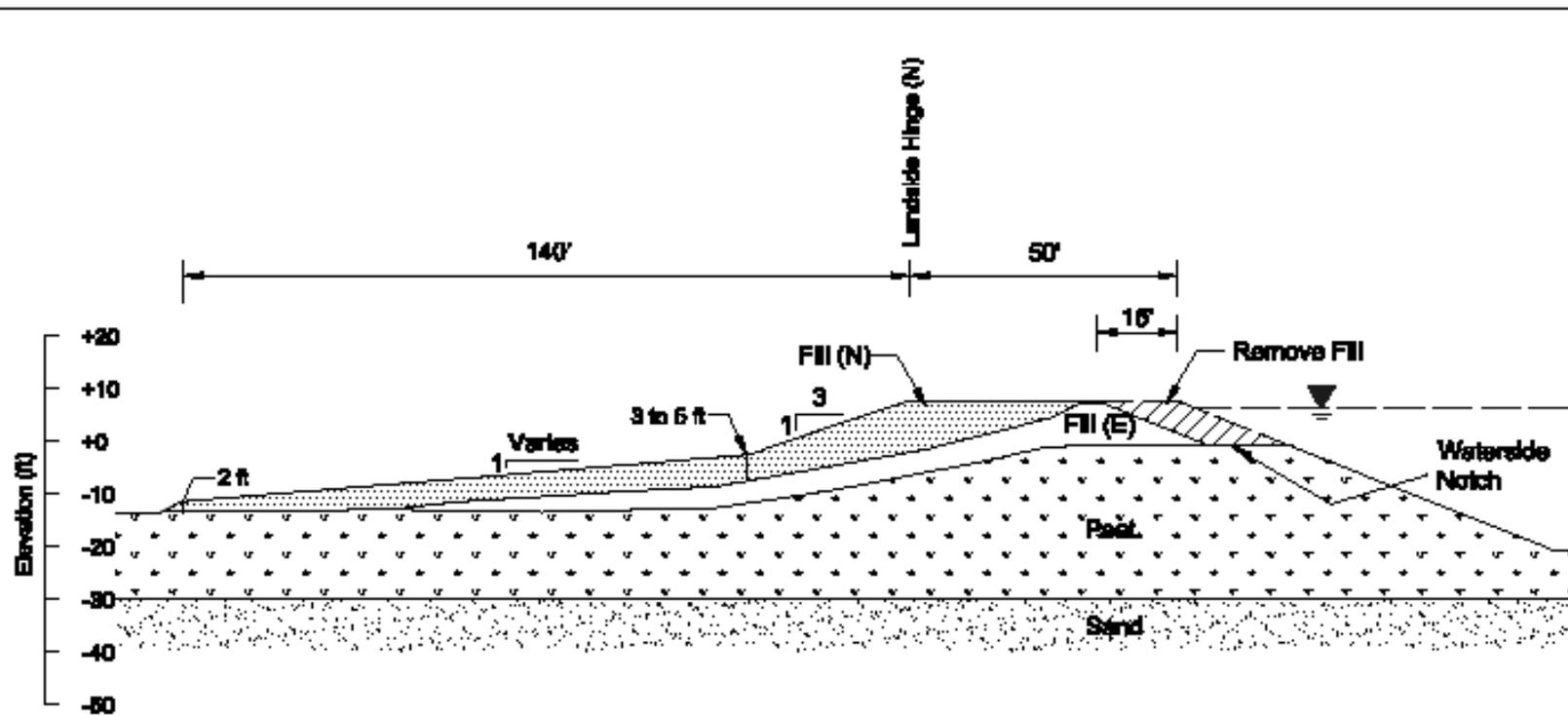


SCALE



1 inch = 30 feet

| | | | |
|--|--|--|-------------|
| Seismically Repairable Levee Webb Tract Sacramento-San Joaquin Delta, California | | Widened Canal with Waterside Butresses | |
| Hultgran - Tillis Engineers | | Project No. 113.16 | Plate No. 6 |

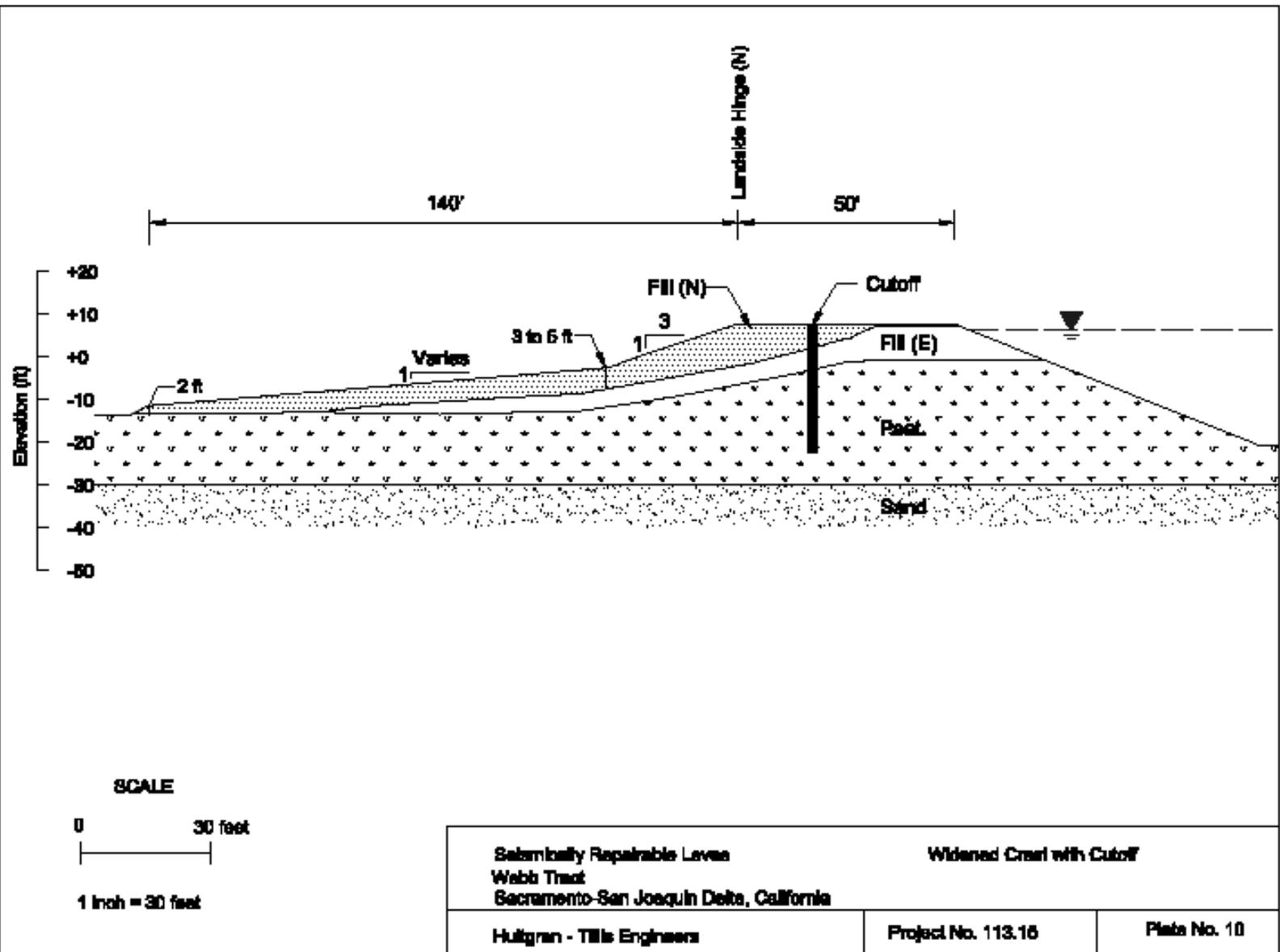


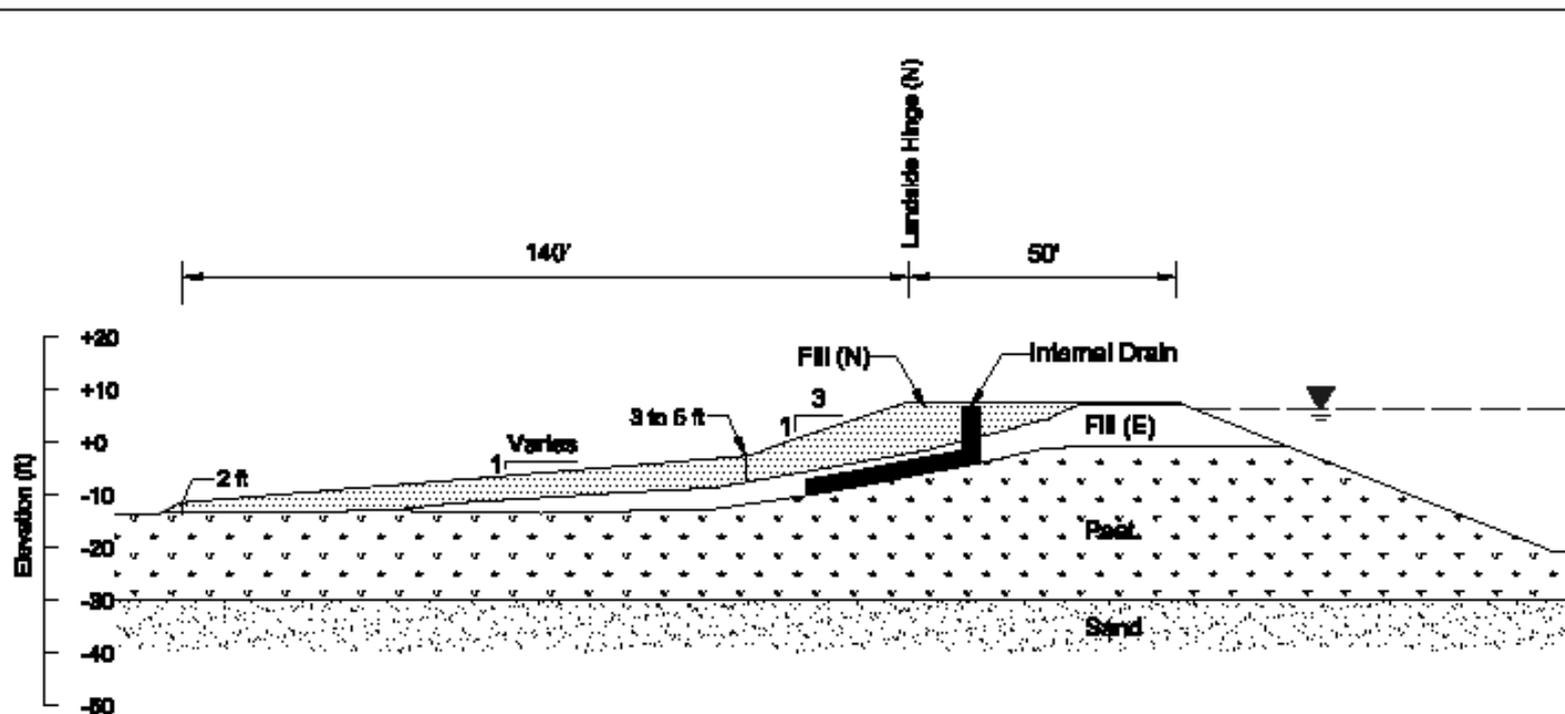
SCALE



1 inch = 30 feet

| | | | |
|--|--|--------------------|-------------|
| Substantially Repairable Levee Webb Tract Sacramento-San Joaquin Delta, California | | Waterside Notch | |
| Hultgren - Tills Engineers | | Project No. 113.15 | Plate No. 9 |





SCALE



1 inch = 30 feet

Note: Base of internal drain will tie to a collection system and/or subdrain.

| | | | |
|--|--|-----------------------------------|--------------|
| Seismically Repairable Levee Webb Tract Sacramento-San Joaquin Delta, California | | Widened Canal with Internal Drain | |
| Hutgran - Tills Engineers | | Project No. 113.15 | Plate No. 11 |

Data Gaps

- Liquefaction in the existing sand fills is the primary seismic risk
- Lateral extent of sand within fills is not well known or well documented
- Extent of sand below marsh soils is better defined but still insufficient to make delta wide conclusions on seismic performance