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FRAMEWORK FOR THE ESTIMATION OF MSW UNIT WEIGHT PROFILE

by

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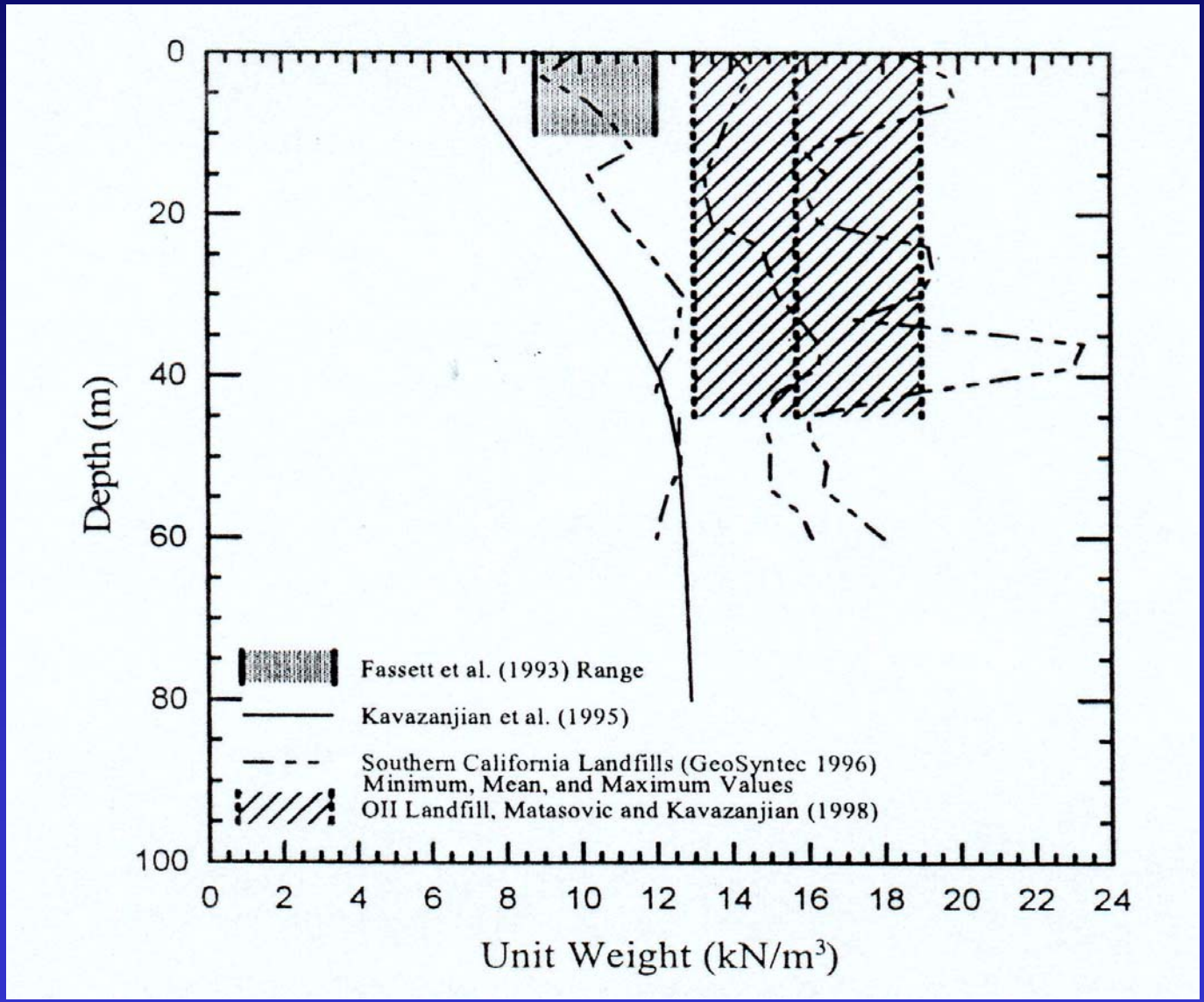
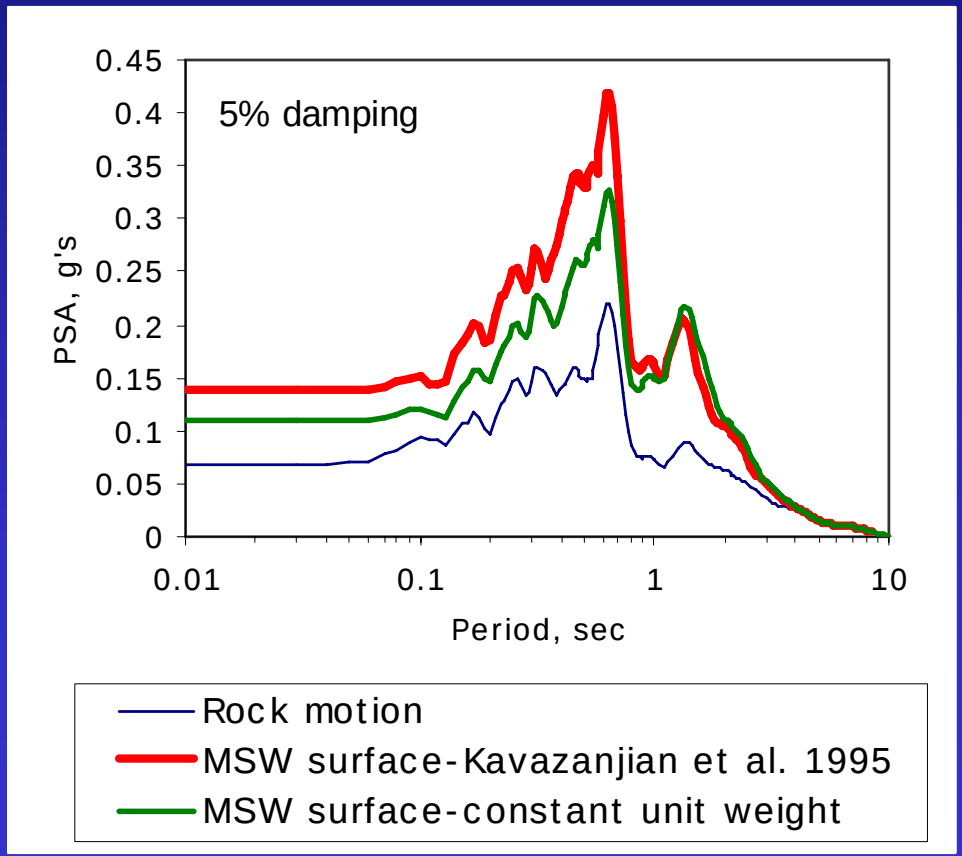
Significant Uncertainty in Current MSW Unit Weight Estimates



Augello et al. 1998

MSW Unit Weight Is Important

- Large range of MSW unit weight, e.g. 5 - 15 kN/m^3"
  - Differ by factor of 3!
- Liner interface strength depends on overburden stress
- Landfill capacity estimates depend on MSW unit weight
- Seismic performance depends on MSW unit weight profile



Methods to Evaluate MSW Unit Weight

1. Landfill Records and Post-Placement Surveys

2. Unit Weight Measured from Conventional Geotechnical Sampling

3. **In-Situ Large-Scale Test Pits or Large-Diameter Boreholes**

   (mimics sand cone density tests with calibrated gravel)

In-Situ Large-Diameter Borehole Method

1. Auger and collect waste

2. Weigh waste collected over interval (W_{waste})

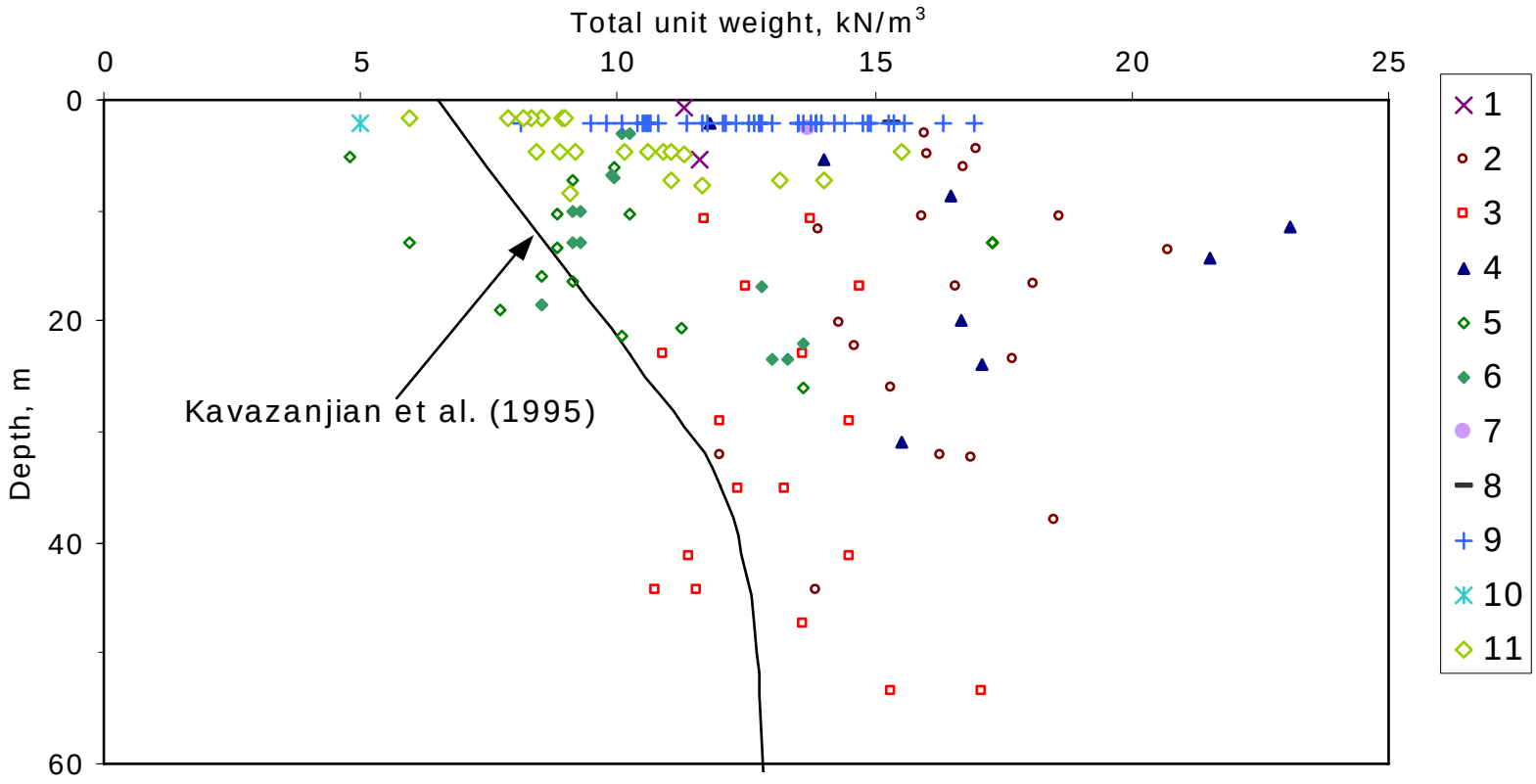
3. Place tremie pipe in borehole

4. Fill with gravel of known unit weight (V_{waste})

$$\gamma_{waste} = \frac{W_{waste}}{V_{waste}}$$

Developed by Kavazanjian and Matasovic for OII Landfill

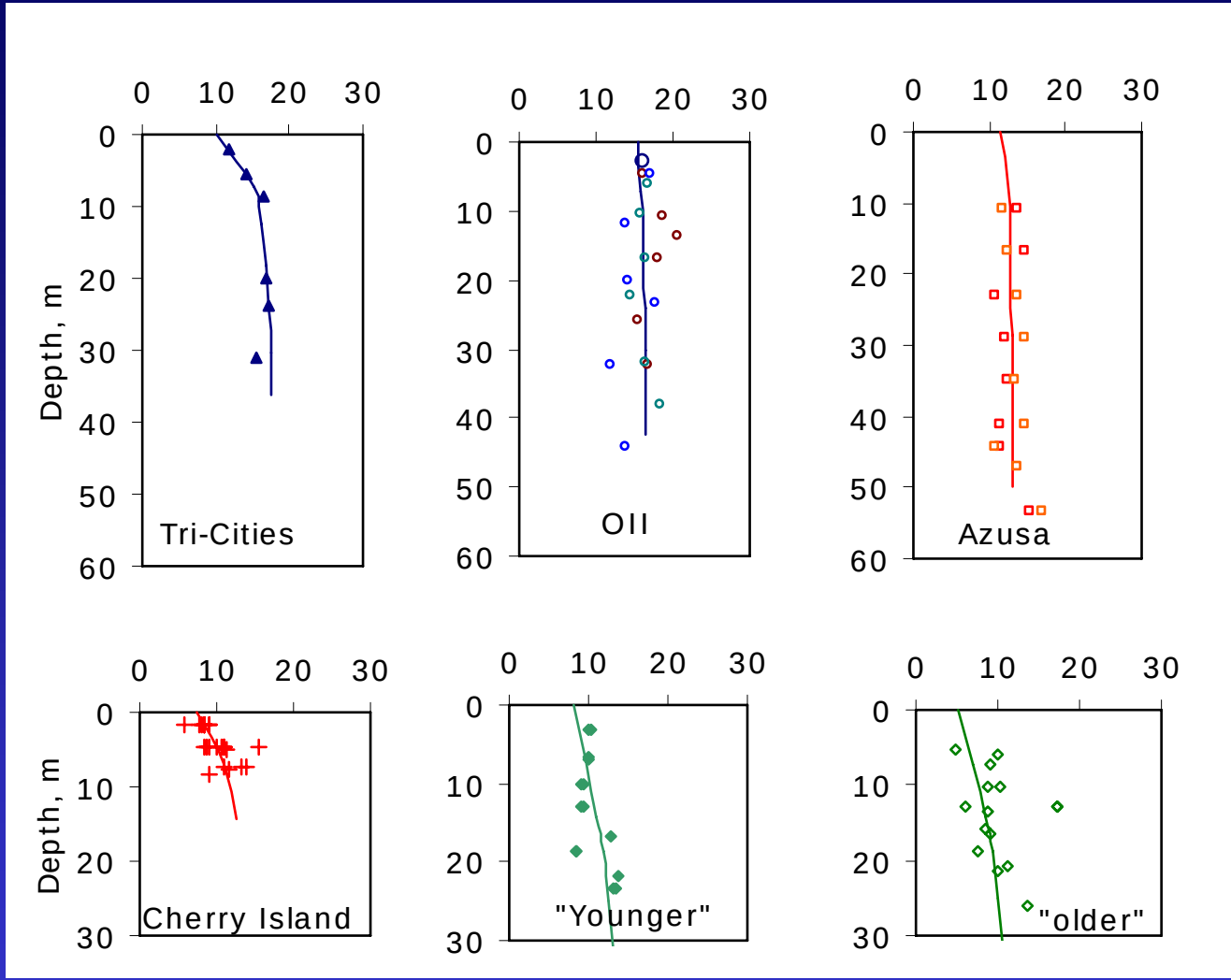
Large Scatter in Reliable MSW Unit Weight Data



(1) Santo Tirso, Portugal (Gomes et al. 2002); (2) OII, California, USA (Matasovic and Kavazanjian, 1998); (3) Azusa, California, USA (Kavazanjian et al, 1996); (4) Tri-Cities, California, USA (this study); (5) no name older landfill (Oweis and Khera, 1998); (6) no name younger landfill (Oweis and Khera, 1998); (7) Hong Kong, China (Cowland et al. 1993); (8) Central Mayne landfill, USA (Richardson and Reynolds, 1991); (9) 11 Canadian landfills (Landva & Clark, 1986); (10) Valdemingomez, Spain (Pereira et al. 2002); (11) Cherry Island landfill, Delaware, USA (Geosyntec, 2003);

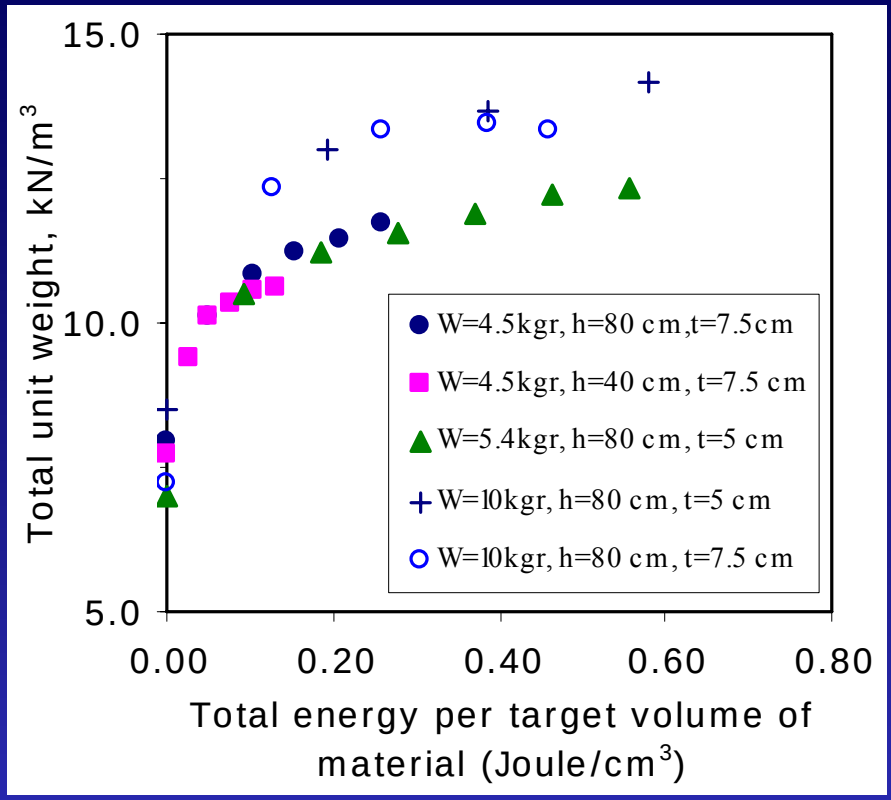
Data from reliable in-situ large-scale methods available in Zekkos et al. (2005) Berkeley Geotechnical report

Characteristic MSW Unit Weight Profile Exists



Geosyntec (2003), Matasovic and Kavazanjian (1998), Kavazanjian et al (1996), Oweis and Khera (1998), Zekkos et al (2005)

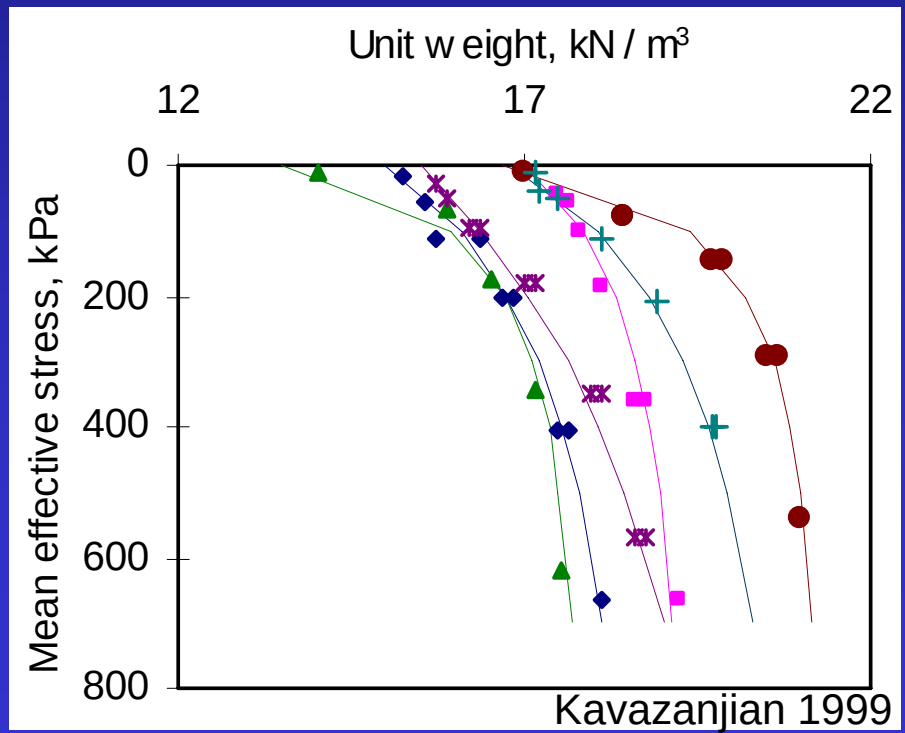
- **Need landfill-specific data**
- **Model can be developed to capture change with depth**



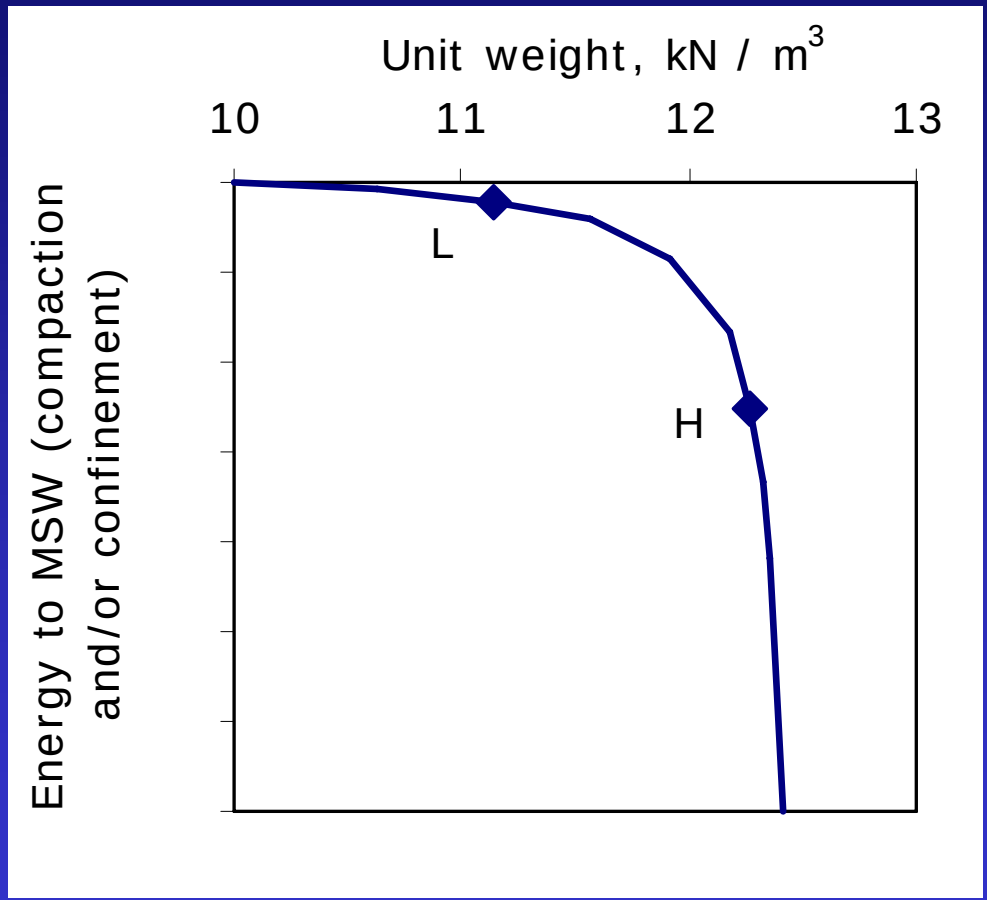
(Tri-Cities Landfill data)

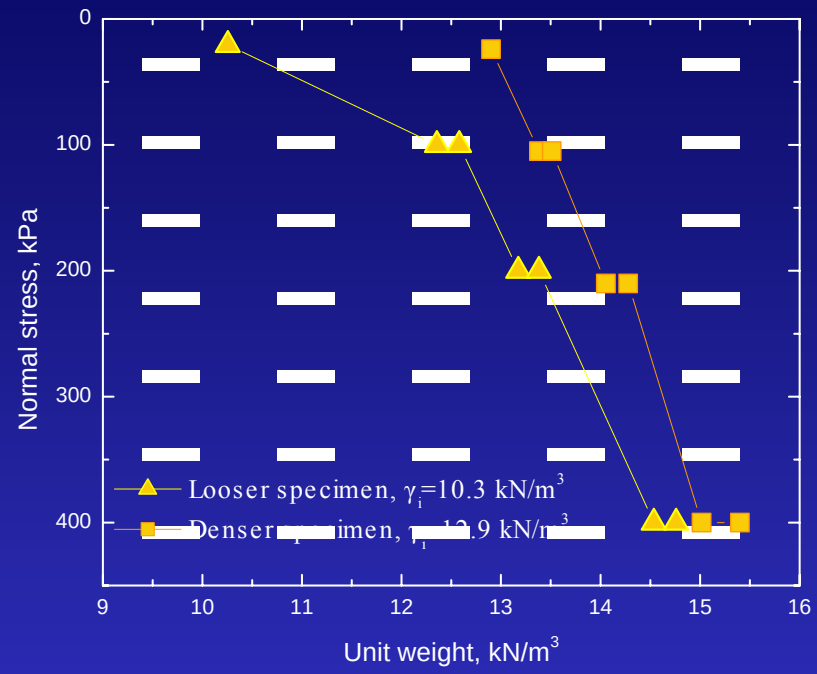
Compaction Level (& waste composition) Determines Initial MSW Unit Weight

Confining Stress Determines Variation of MSW Unit Weight with Depth



Hyperbolic Relationship

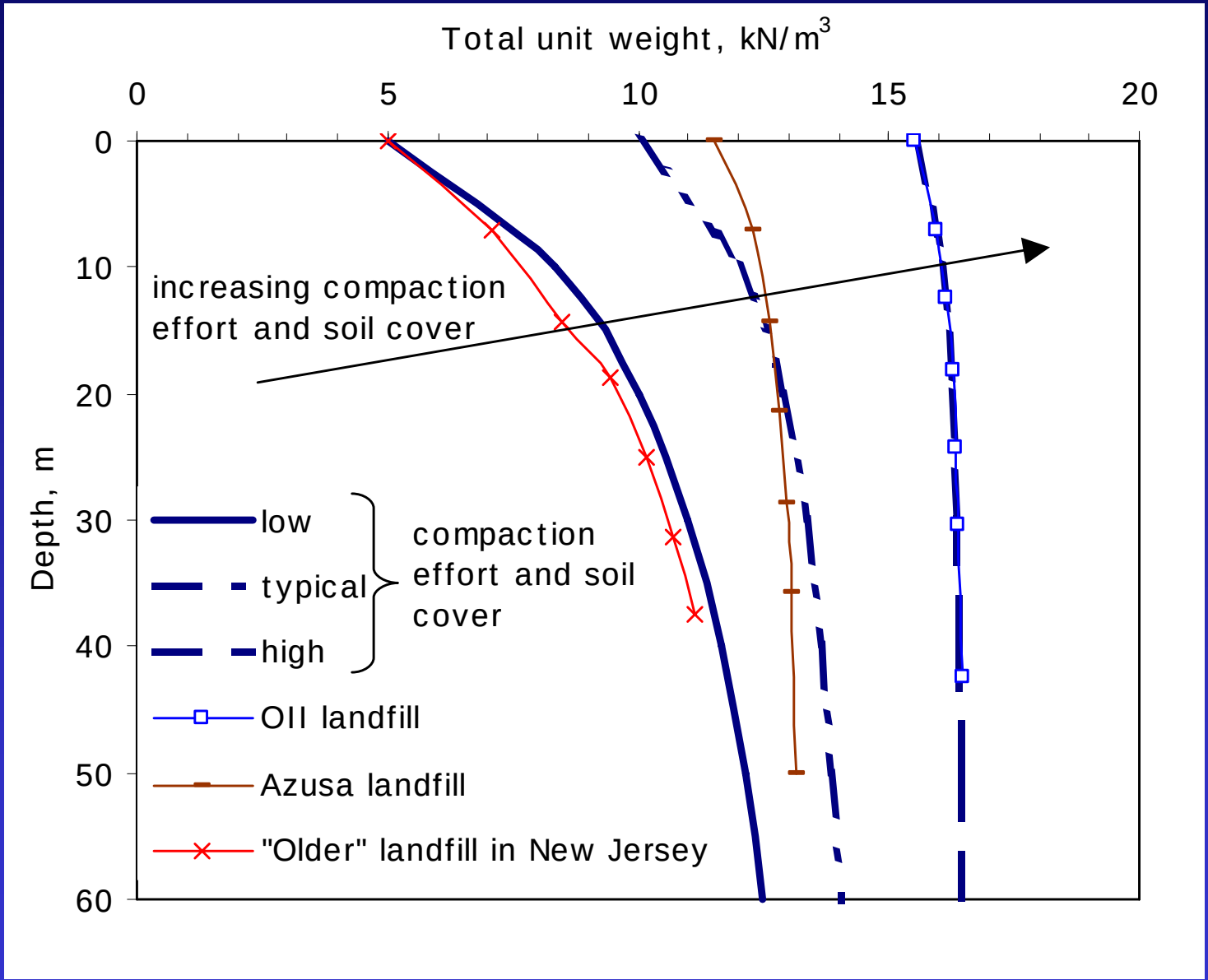




$$\gamma = \gamma_i + \frac{z}{\alpha + \beta \cdot z}$$

Depending on initial unit weight, increase in depth produces large or small increase in unit weight

Characteristic MSW Unit Weight Profiles



RECOMMENDATIONS FOR PRACTICE

(A) Design based on a comprehensive investigation

Step 1: Measure MSW unit weight near surface using test pits

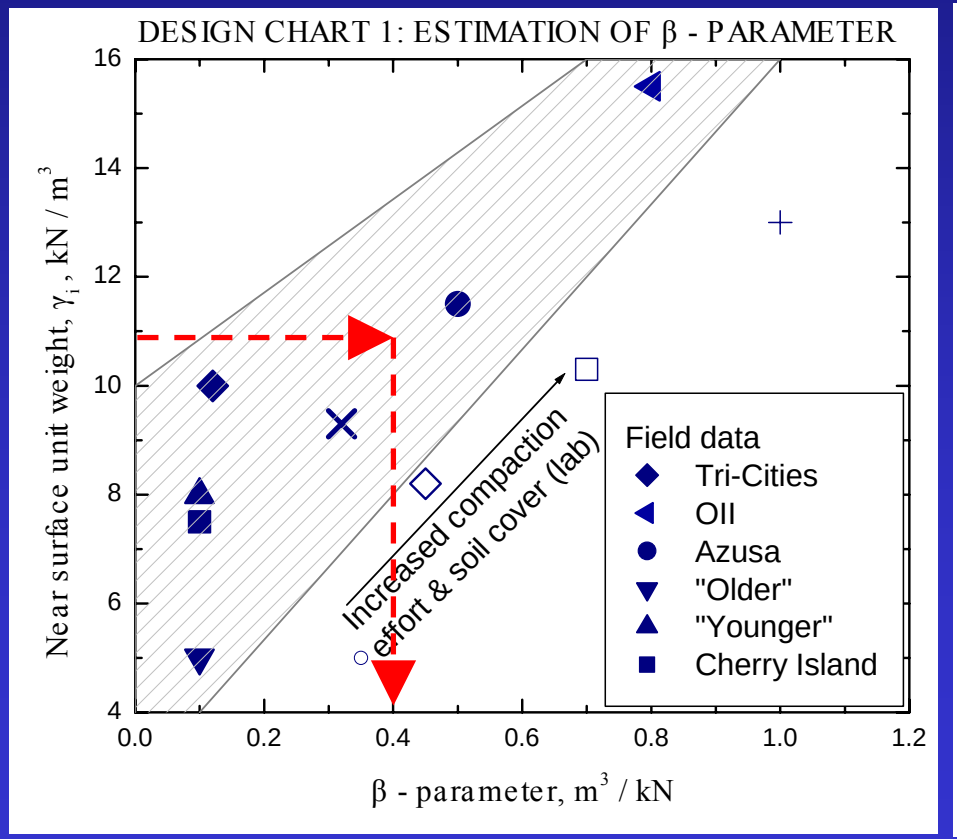
Step 2: Measure MSW unit weight at greater depths using large-diameter boreholes

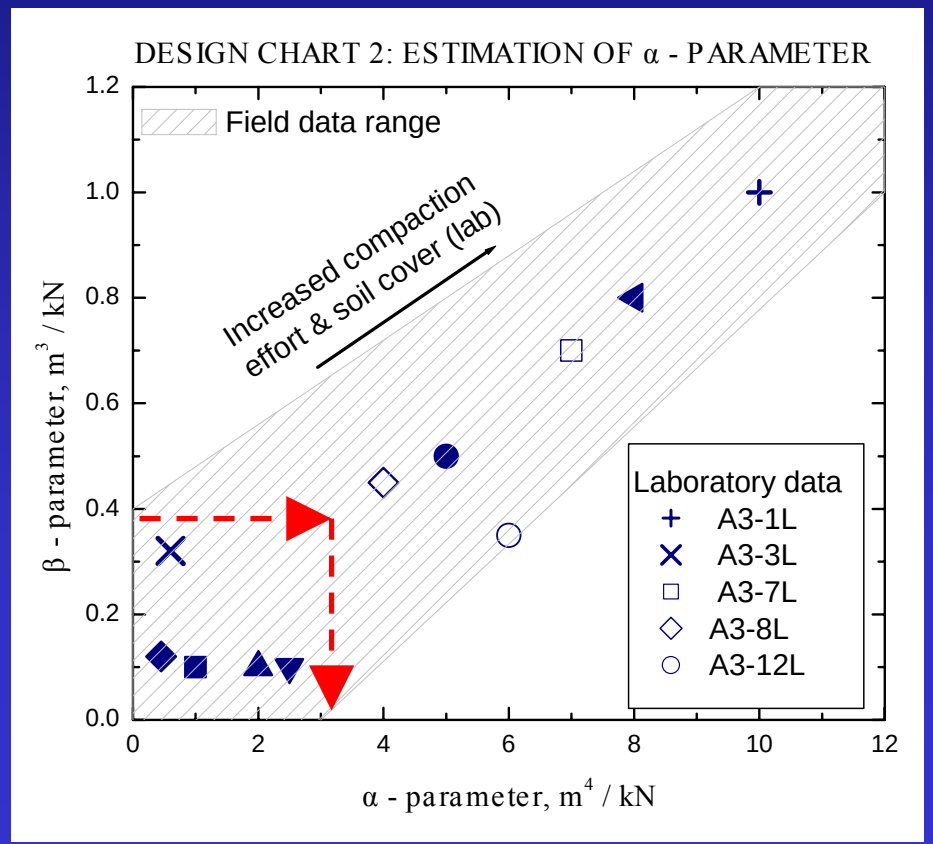
Step 3: Develop MSW unit weight profile using hyperbolic model

(B) Estimates based on a limited investigation

- *Step 1: Estimate MSW unit weight near the surface using test pits, landfill records, or published values (γ_i ~ 13 kN/m^4)*
- *Step 2: Use design charts to estimate α and β parameters (β = 0.4 m^3/kN and α = 3 m^4/kN)*

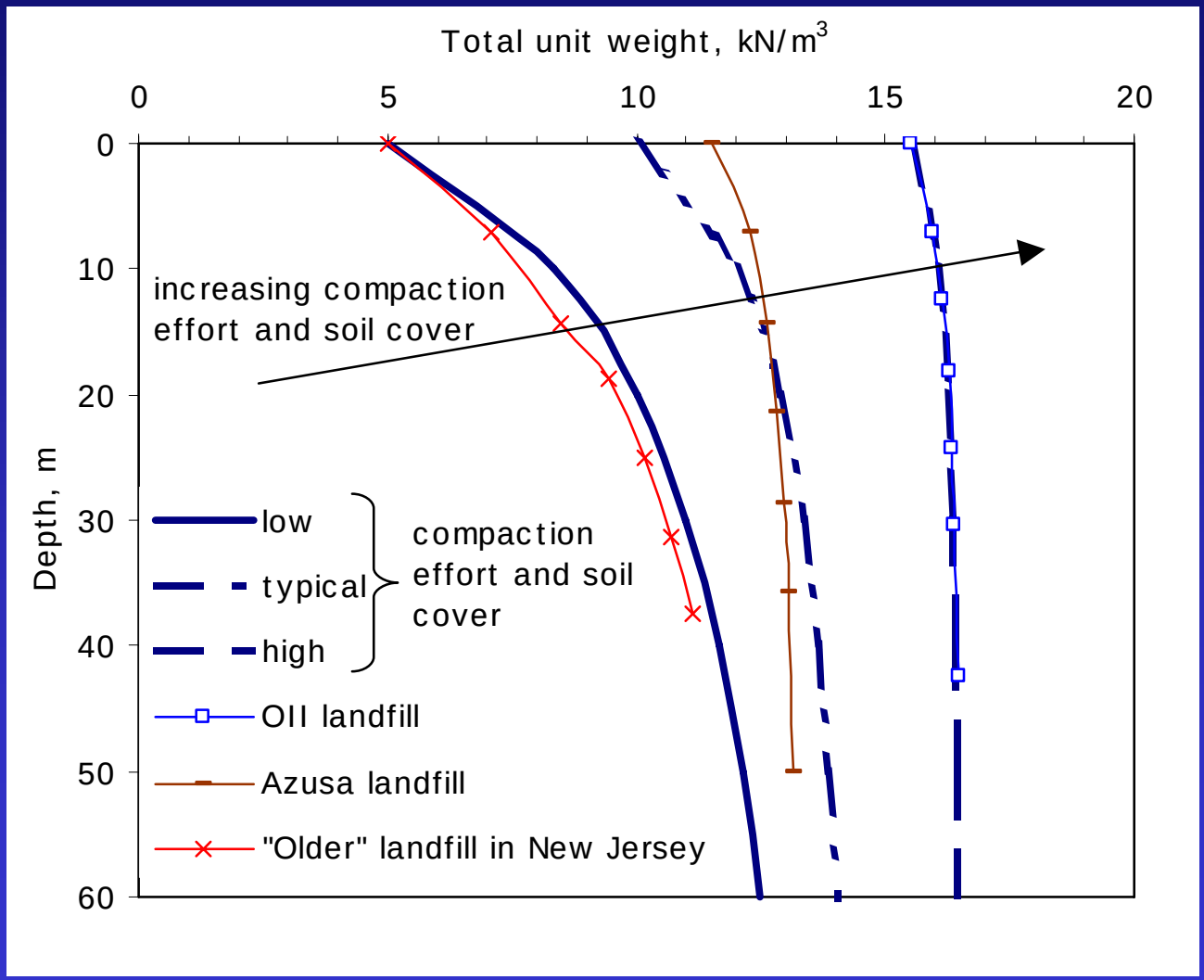
$$\gamma = \gamma_i + \frac{z}{\alpha + \beta \cdot z}$$





(C) Design of a new landfill

Use MSW unit weight profiles for low, typical, or high compaction effort and soil cover



Conclusions

$$\gamma = \gamma_i + \frac{z}{\alpha + \beta \cdot z}$$

- Comprehensive MSW unit weight database has been developed
- A characteristic MSW unit weight profile exists for each landfill
- A hyperbolic model can capture the dependence of MSW unit weight on its composition, compaction effort, and confining stress
- The developed model was calibrated with reliable in-situ landfill unit weight data as well as large-scale laboratory data.
- Landfill-specific data are important for establishing the near surface (initial) unit weight of MSW
- Hyperbolic model can extend near surface data to greater depths

Thank you

Additional information available at the Geoengineer website at:

http://www.geoengineer.org