Engineering Perspective of Urbanized Stream Restoration Projects

ACWC Annual Conference

Urbanized Watersheds

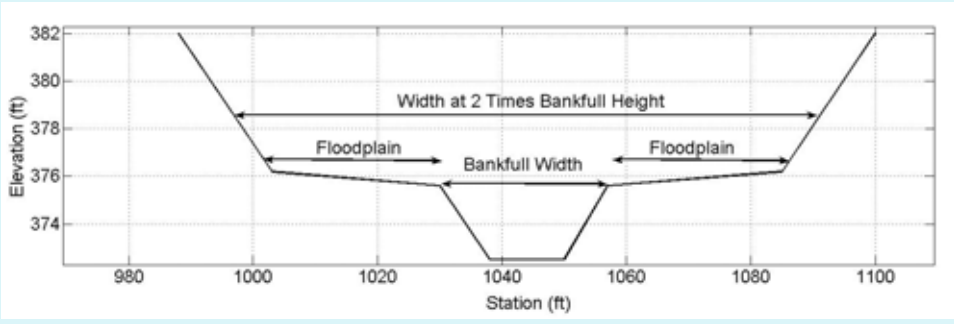
Incised Stream Channel

Remnant of Pre-urbanization channel geometry

Questions

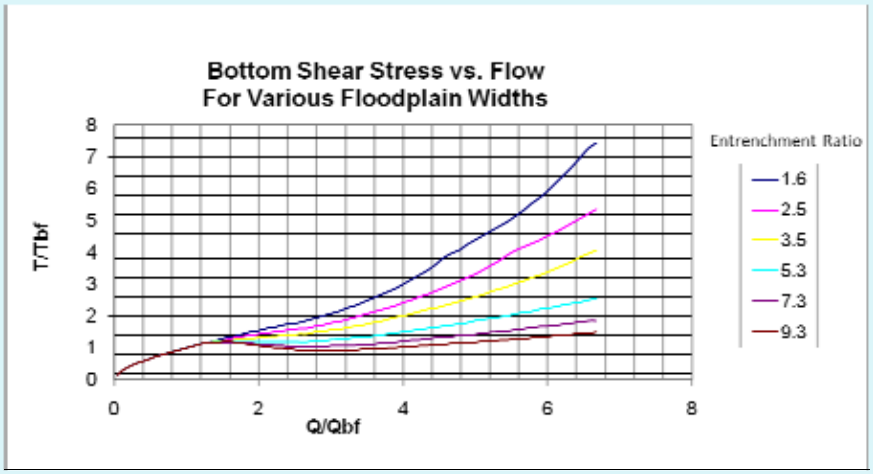
- *How does incised channel geometry change restoration design criteria, e.g., design flow, height of bank protection?*
- *How should we manage urbanized watershed, vis-a-vis fallen trees, vegetation growth?*
- *How do geomorphic characteristics sustain in urbanized environment?*

Bankfull and Floodplain

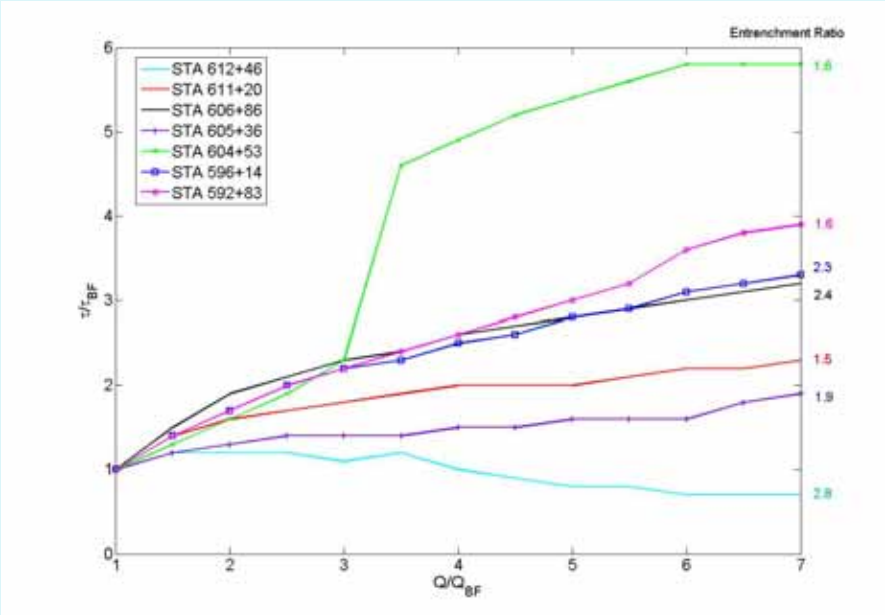


Entrenchment Ratio = ratio of channel width at 2xbankfull depth to bankfull depth
Bottom shear stress $\tau = \gamma RS$

Bankfull Effect on Bottom Shear

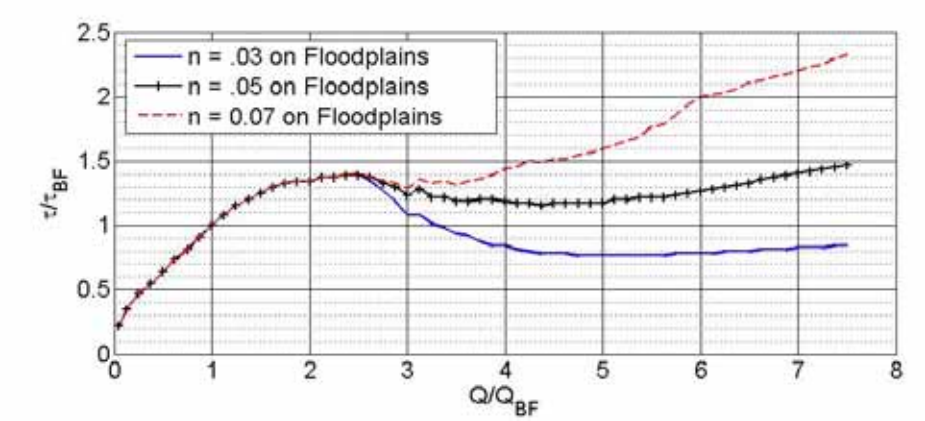


Dimensionless τ vs. Q



Calabazas Creek 400’ u/s Comer Drive

Effect of Roughness on Floodplains



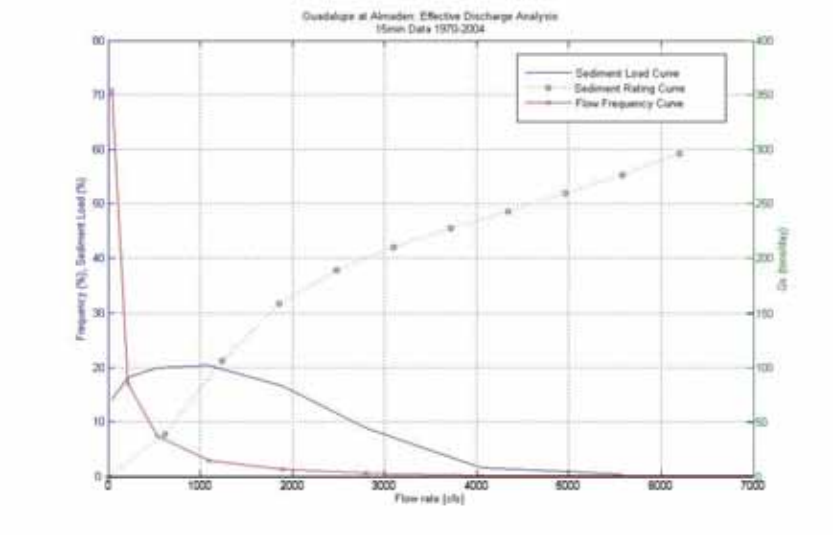
Entrenchment Ratio = 3.5

A moment to reflect…

- Incised channel is intrinsically unstable in that bottom shear stress increases with flows
- Floodplain provides an asymptotic limit to bottom shear stress
- Thick vegetation and fallen large woody debris on the floodplain counteracts the effect of floodplain
- Design flow for incised channel should be determined based on shear stress analysis to properly weigh risk vs. objective

Stream Gauge Stations

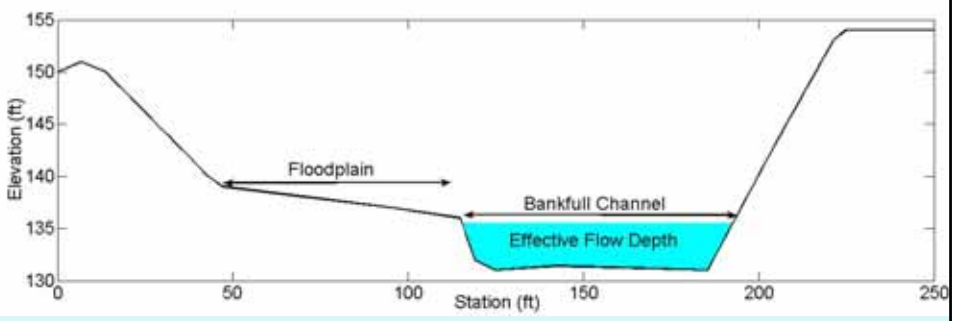
Effective Flow Calculation



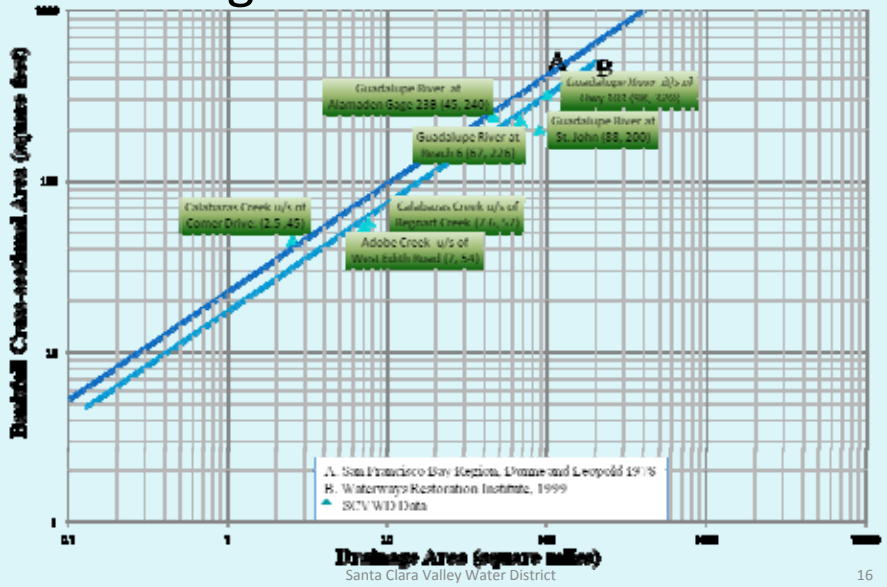
Effective Flow Calculation Results

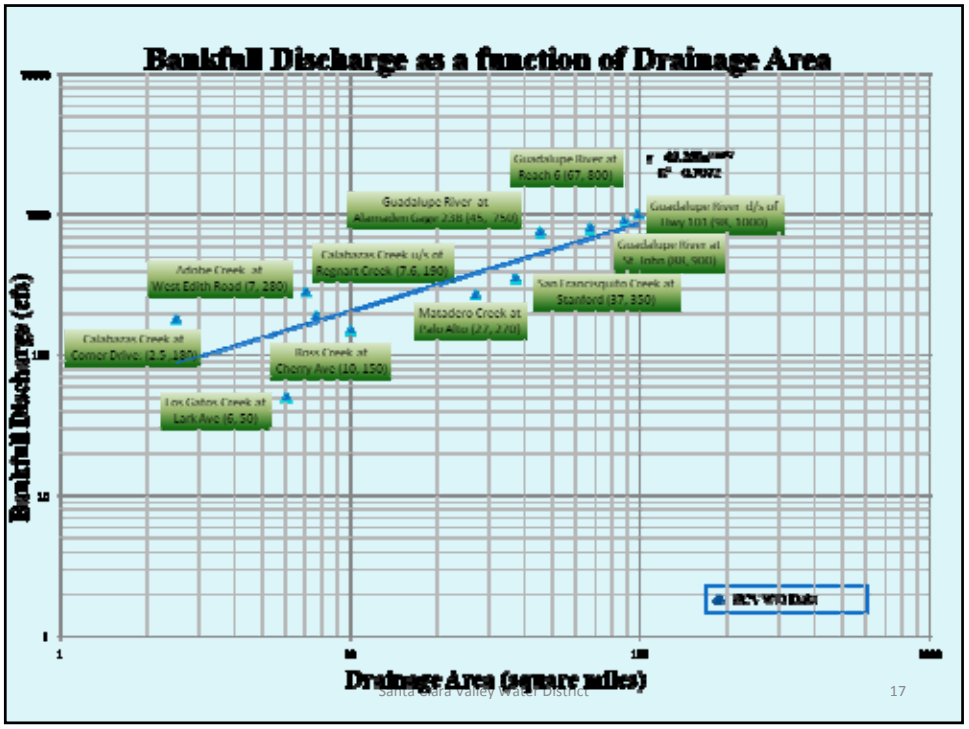
Gauge Station	Available Gauge Data	Drainage Area (sq mi)	Effective Flow (cfs)	Sediment Transported	Exceedance Frequency (Return Period)
Los Gatos Creek at Lark Ave	1992-2007	6 (44)*	50	45%	94% (1.1)
Ross Creek at Cherry Ave	1956-2007	10	100-200	54%	95-99% (1-1.1)
San Francisquito Creek at Stanford	1987-2007	37	200-500	66%	86-95% (1.1-1.2)
Guadalupe River at Almaden	1970-2004	45 (70)*	700	55%	78-86% (1.2-1.3)
Guadalupe River at Saint John	1987-2003	88 (150)*	900	60%	88% (1.1)
Calabazas Creek at Lawrence	1972-2004	12	250-350	54%	93-97% (1-1.1)
Matadero Creek at Palo Alto	1987-2007	27	270	50%	80% (1.3)

( )* denotes drainage area including the areas upstream of the reservoir



Drainage Area vs. Bankfull X-sec





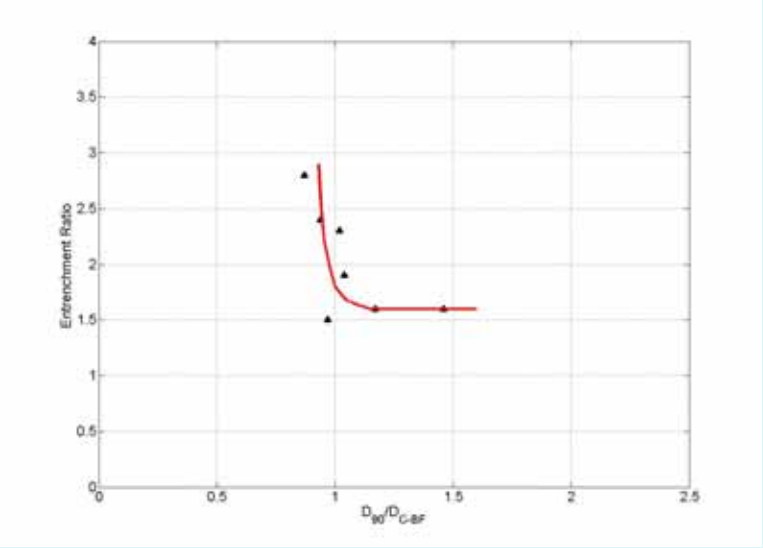
Surface Armor

- When does it exist ?

Effect on Surface Armor

Station	$Q_{bankfull}$ (cfs)	D_{50}	D_{90}	$\tau_{bankfull}$ (lb/ft²)	$D_{c\text{-}BF\ (inch)}$	$D_{90}/D_{c\text{-}BF}$	Entrenchment Ratio
612+46	120	1.5	3	1.39	3.5	0.85	2.8
611+00	120	2	3.5	1.45	3.7	0.95	1.5
606+86	120	2	2.5	1.07	2.7	0.92	2.4
605+50	120	2	4	1.55	3.9	1.02	1.9
604+50	120	1.2	2.1	0.72	1.8	1.15	1.6
596+14	120	1	2	0.79	2.0	1.00	2.3
592+83	120	1	2	0.55	1.4	1.43	1.6

Effect of Floodplains on Surface Armor



Summary

- Effective flow = Bankfull flow
- Approx. 1.1 – 1.3 yr return period
- Surface-armor condition varies with channel geometry
- Determine design Q based on channel geometry & vegetation growth
- Work with regulators to develop watershed specific management guidelines

The End.

Thank you!

Questions?