Post-Fire Watershed Assessment: The Waldo Canyon Fire, Colorado

Wildland Hydrology

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Acknowledgments

- This project was contracted and encouraged through the dedication of Carol Ekarius of the Coalition for the Upper South Platte (CUSP) and the numerous partners. The listed participants also contributed various portions of their time to complete this project.

Partners:

- Pike National Forest
- Natural Resources Conservation Service
- Colorado Water Conservation Board
- Colorado Department of Transportation
- The Navigators/Glen Eyrie
- City of Colorado Springs
- Colorado Springs Utilities
- El Paso County
- Colorado Water Resources and Power Development Authority
- Coalition for the Upper South Platte

Participants:

- **Coalition for the Upper South Platte (CUSP):**
  - Carol Ekarius, Jara Johnson, Jonathan Bruno, Carrie Adair
- **US Forest Service**
  - Kyle Wright, Brian Banks, Dana Butler, Leah Lessard, Molly Purnell, Ed Biery, Melinda McGann
- **Colorado Springs Utilities**
  - David Longrie, Kim Gortz
- **Matrix Design Group**
  - Graham Thompson, Lucas Babbitt
- **Wildland Hydrology**
  - Robert “Bones” Kasun, Lee Chavez

Waldo Canyon Fire (2012)

Burned:

- 18,247Acres
- 346 Homes

Image Source: KKTV 11 News

Goal

Enhance hydrologic recovery to promote sustainable watershed function

Objectives

- Reduce risk to life and property
- Protect existing infrastructure
- Reduce sediment supply from:
  - Hillslopes
  - Roads and trails
  - Channel sources
- Dampen flood peak flows

The following questions are addressed with this restoration master plan:

1. What are the post-fire impacts and potential adverse consequences?
2. What can be done to offset these impacts/consequences?
3. How effective would this be?
4. Where do we start?
5. How much will it cost?
6. When can we start?

1. What are the post-fire adverse impacts? …Debris flows

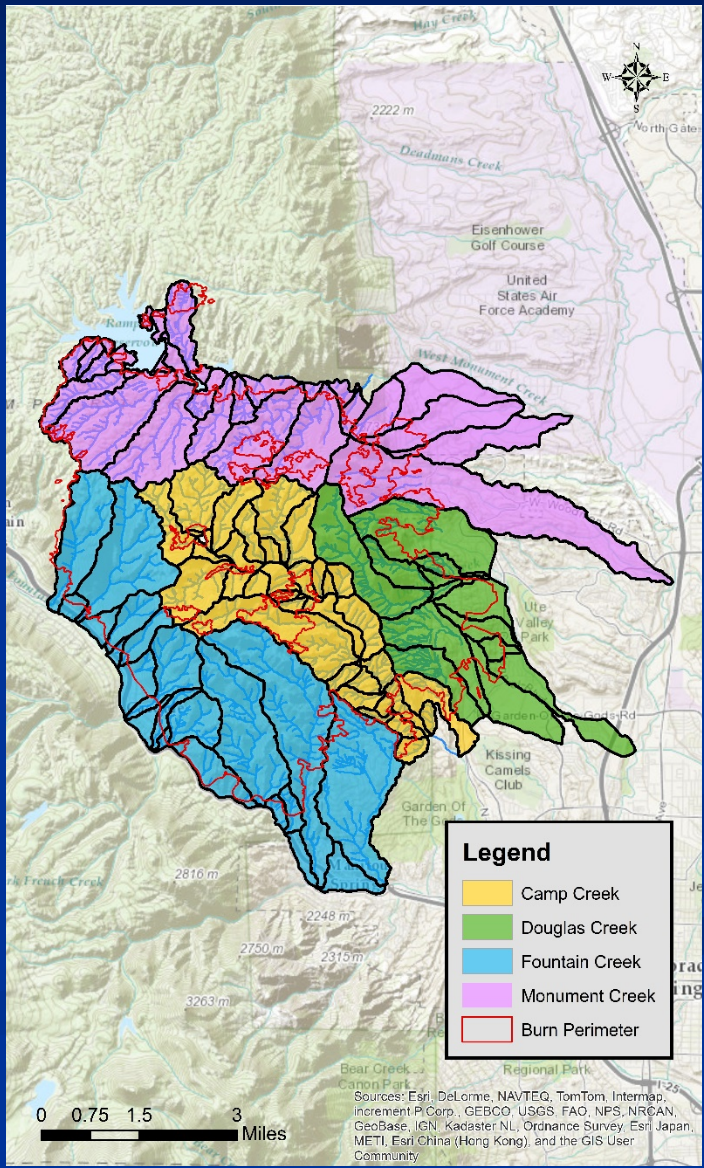
To answer these questions it was necessary to conduct a watershed assessment (WARSSS) to evaluate:

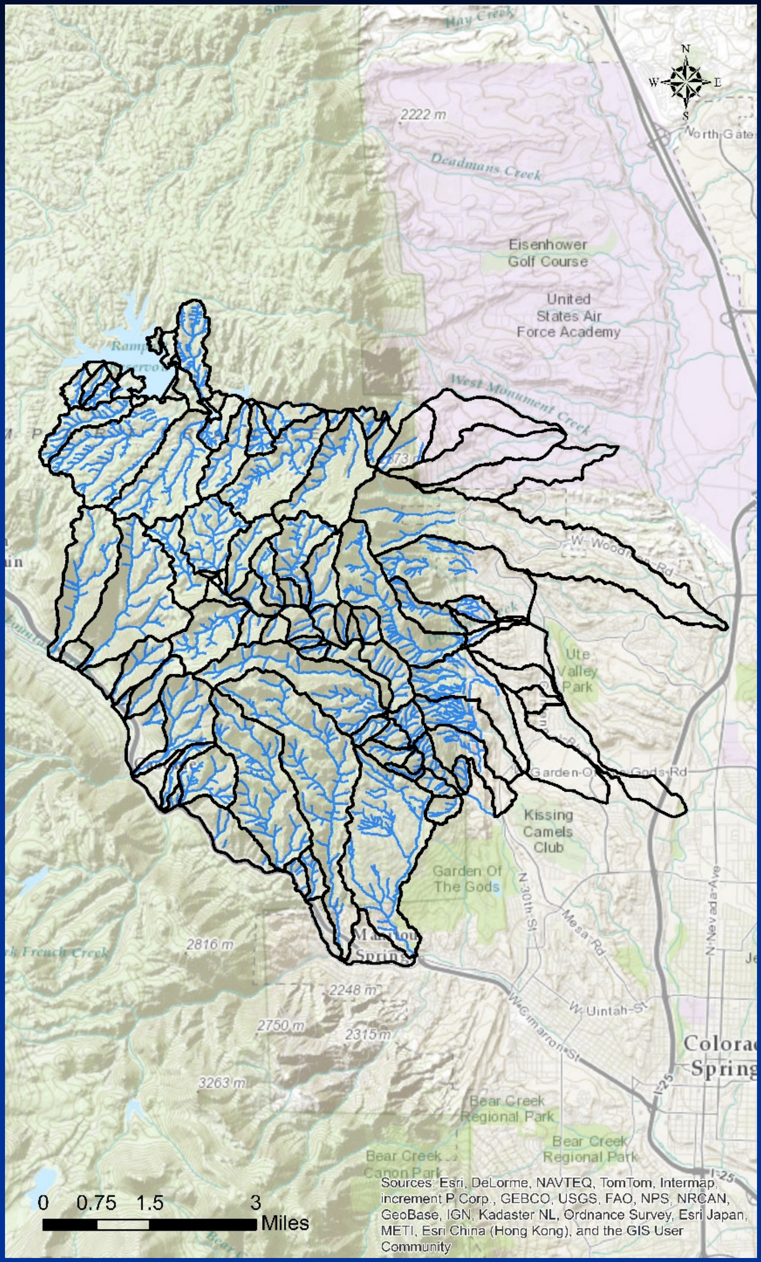
- Hydrology change
- Hillslope erosional processes/sediment supply
- Sediment from roads and trails
- Stream channel processes

WARSSS

Portions of four major watersheds exist within the fire perimeter:

- Camp Creek
- Douglas Creek
- Fountain Creek
- Monument Creek





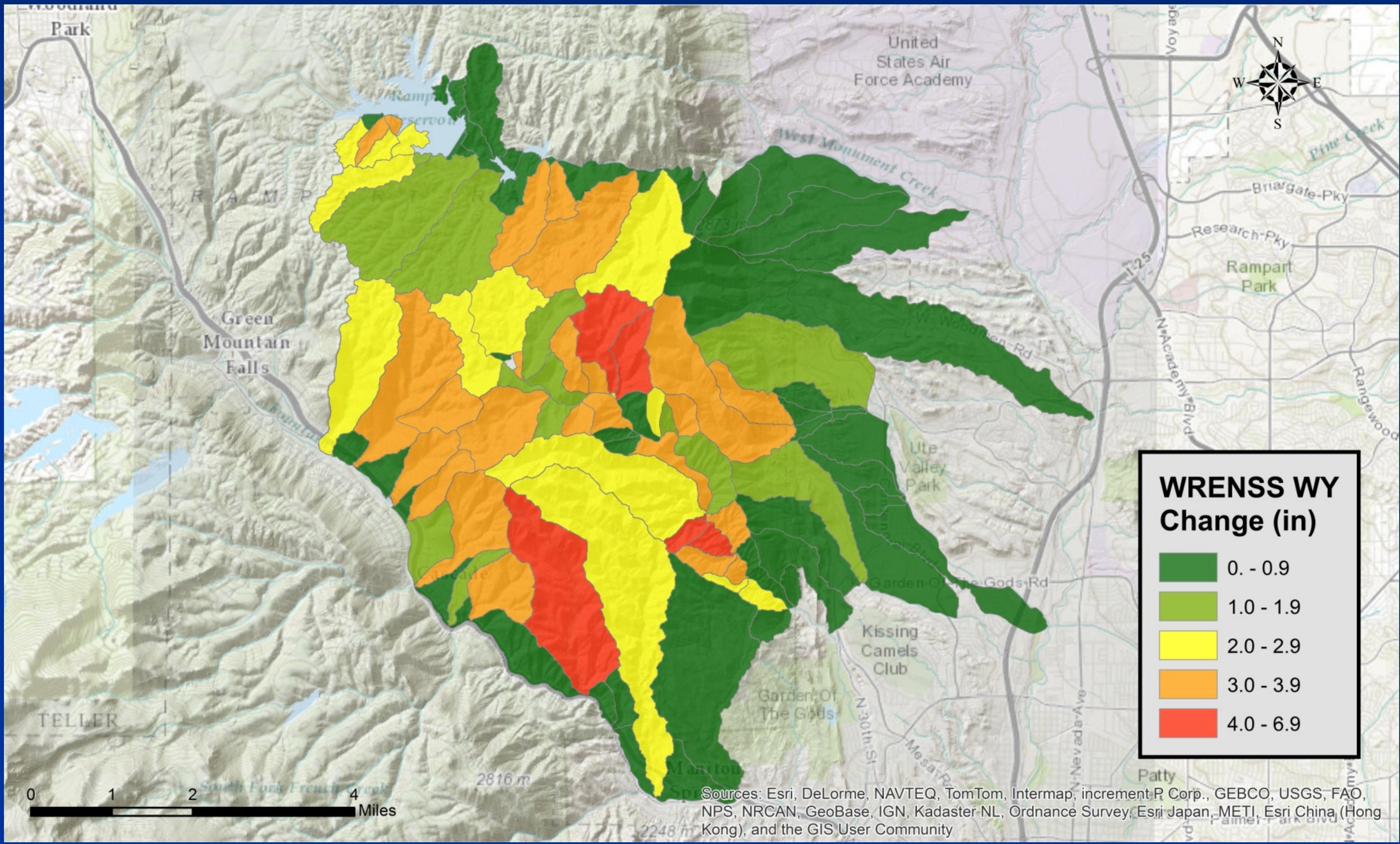
Major watersheds delineated into 89 Sub-watersheds

≈237 miles of stream channel

Change in Hydrologic Response

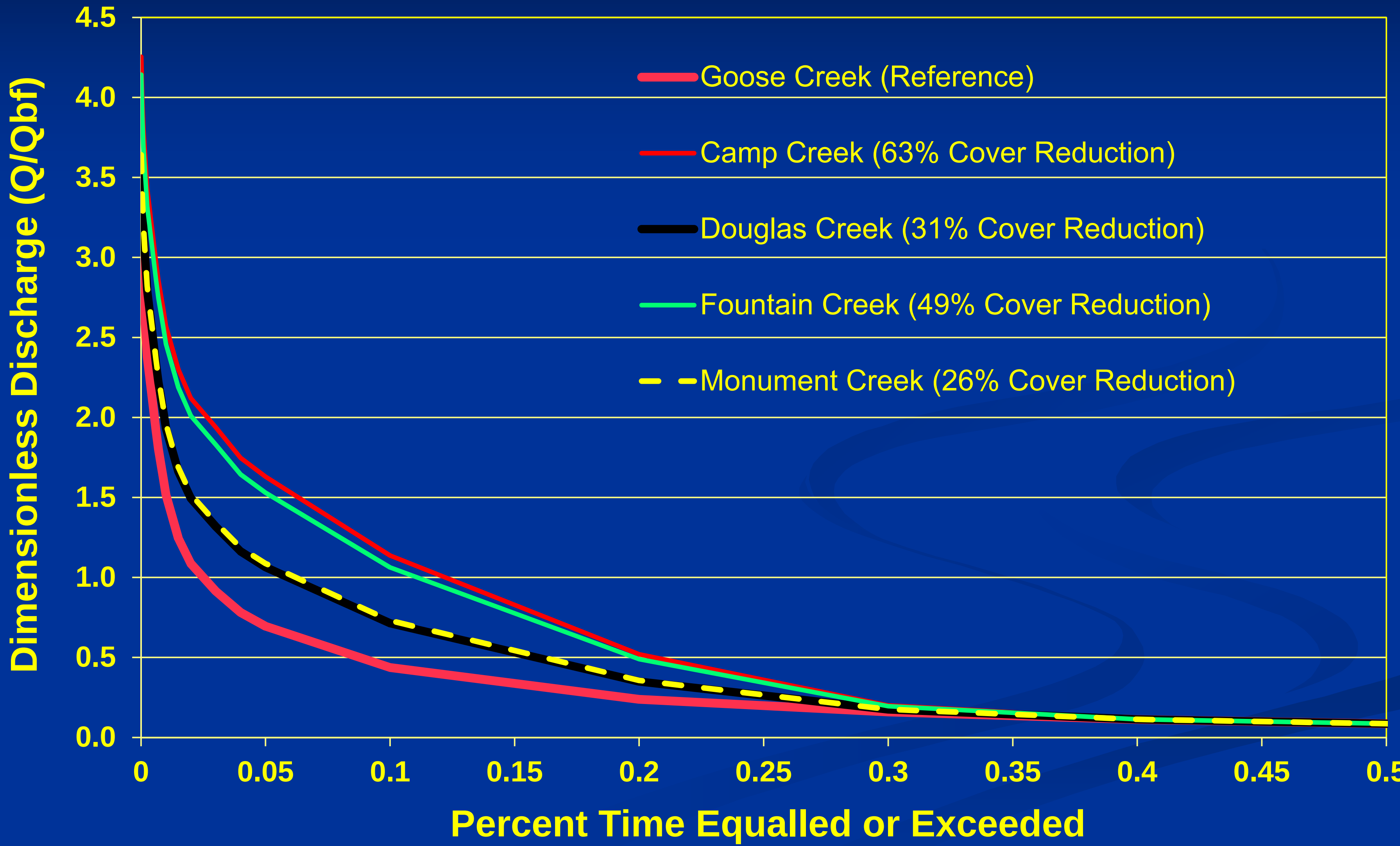
Flood Response to moderate storms

Average Annual Water Yield Increases



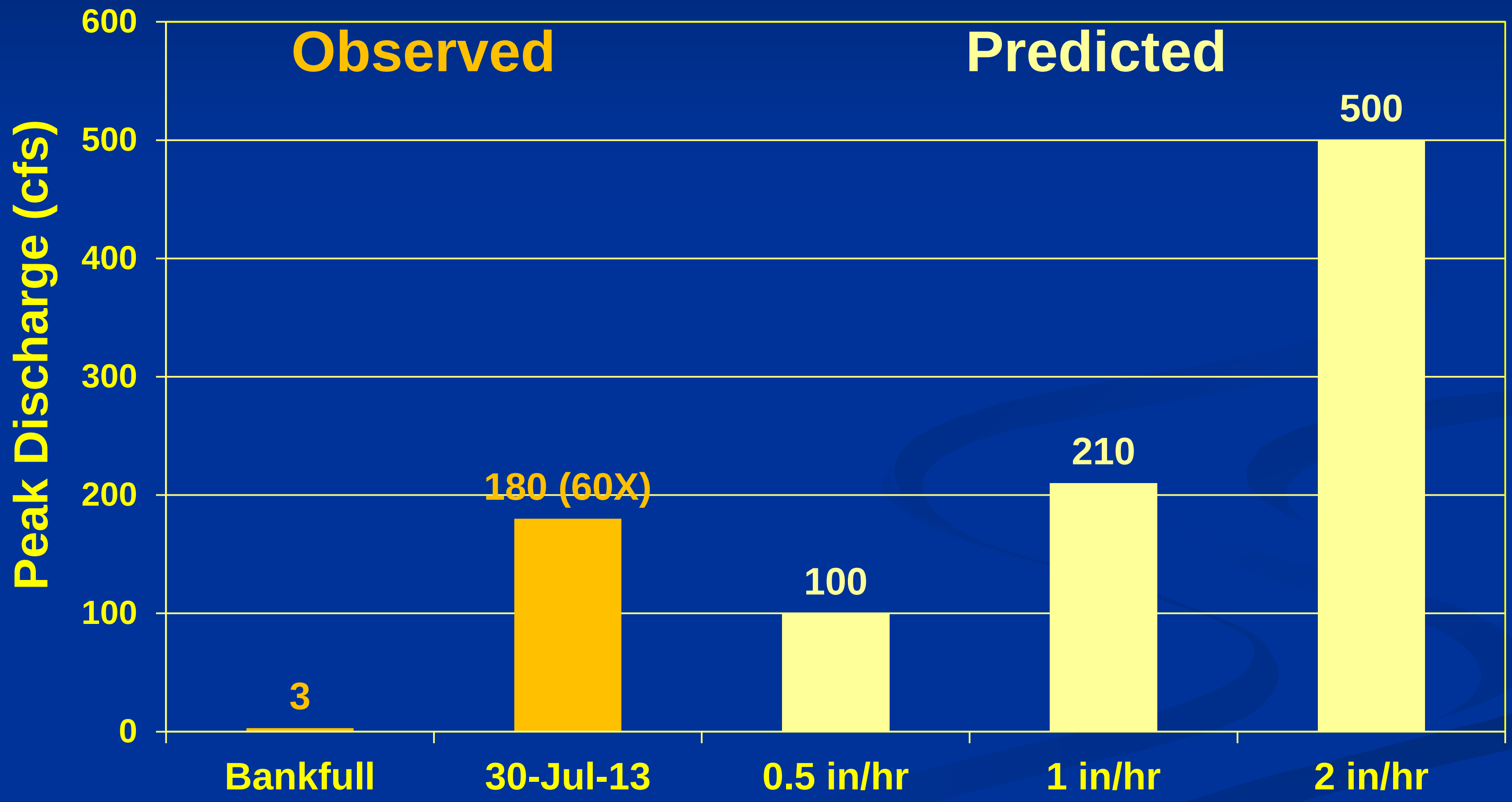
Hydrology: Streamflow Increases

Dimensionless Flow Duration Curves



Change in Hydrologic Response

Flood Peaks: Northfield Gulch



USGS, Bob Jarrett, 1996-2011 Burned Area Flood Data
For 0.5 sq. mi., Rainfall threshold ≈ 0.25 in in 30 minutes

Hydrology: **Streamflow Changes**

Effects of increased flows

Debris Avalanche-Trib. To Coal Basin Cr.. Colorado

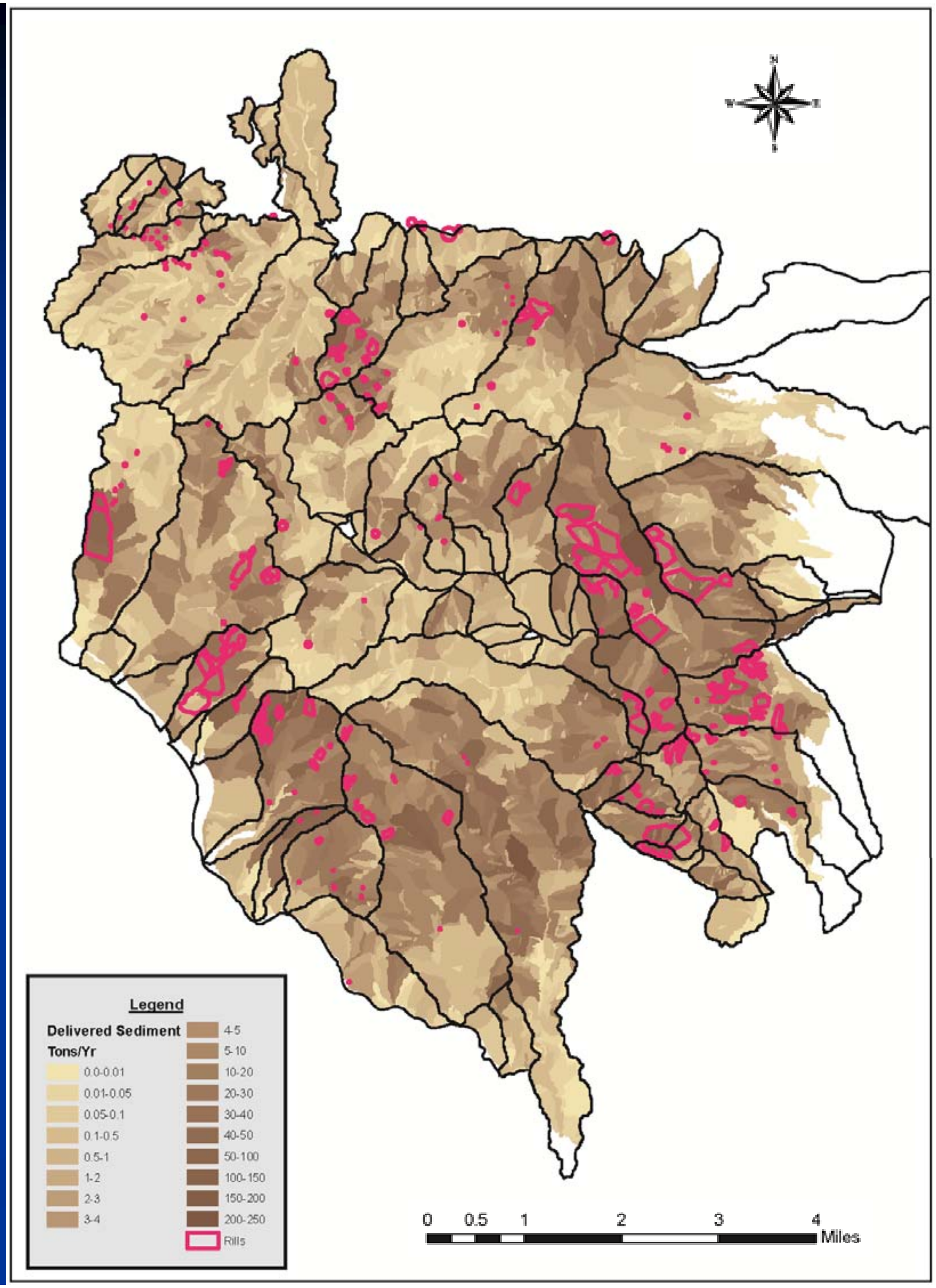
Hillslope Processes: Surface Erosion

Hillslope Surface Erosion

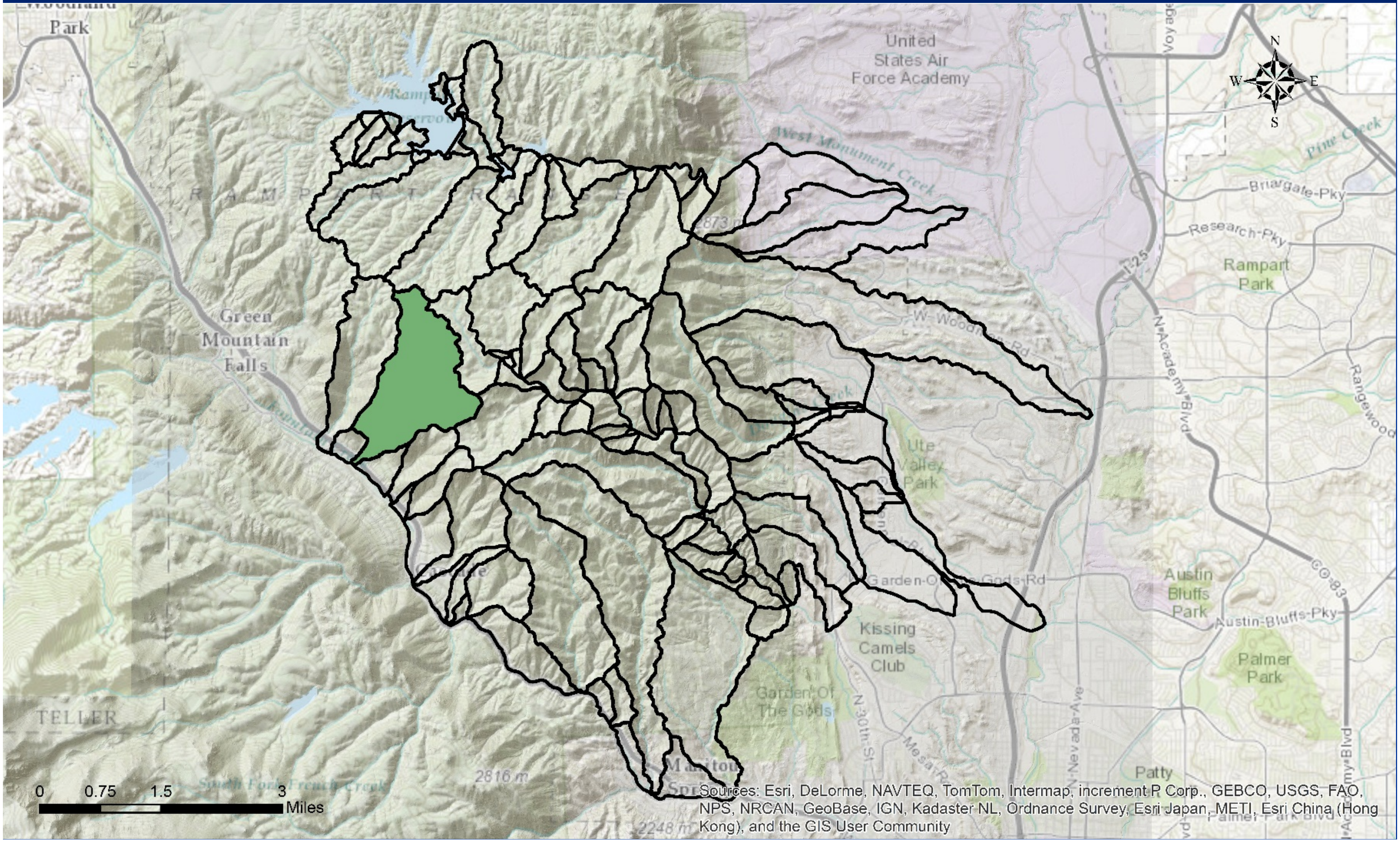
- Account for *18,085 tons/yr* of sediment (35% of total introduced sediment)
  - *Rills*
  - *Lack of Ground Cover*

Distribution of Delivered Sediment from Hillslopes and Rill Location

1. Fountain Creek – 7,303 tons/yr
   - 40%
2. Camp Creek – 4,193 tons/yr
   - 24%
3. Douglas Creek – 4,057 tons/yr
   - 22%
4. West Monument – 2,532 tons/yr
   - 14%

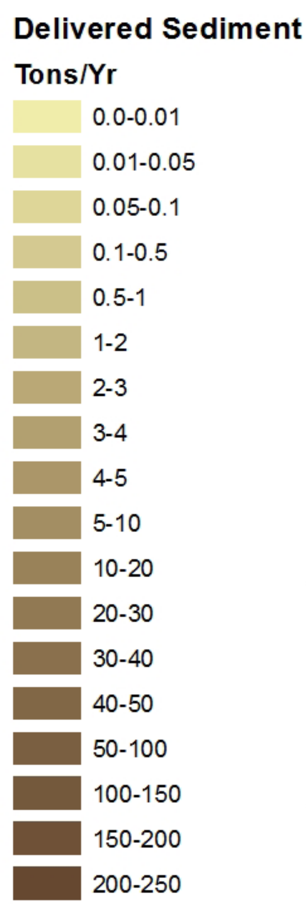


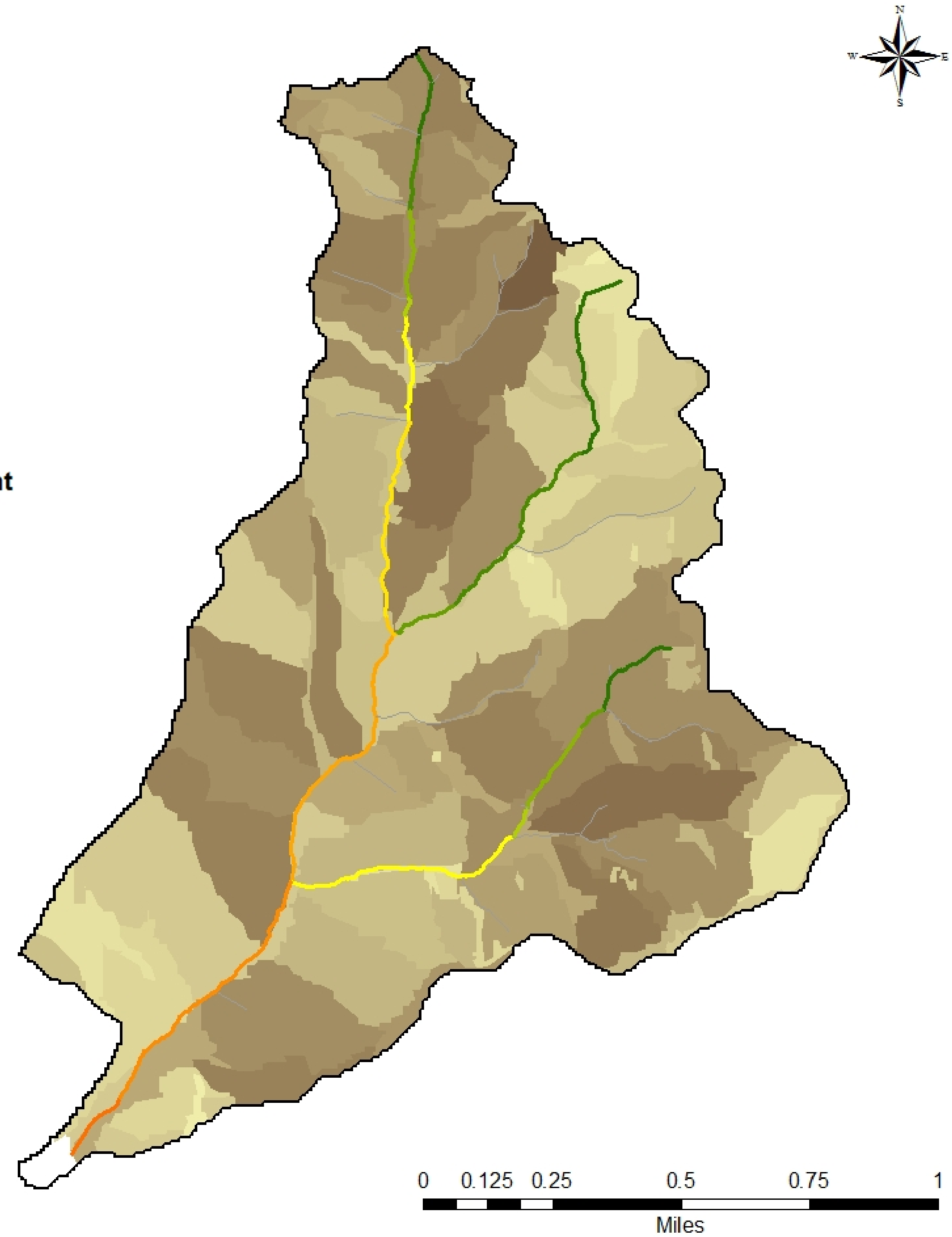
Focus on Wellington Gulch, FC-010



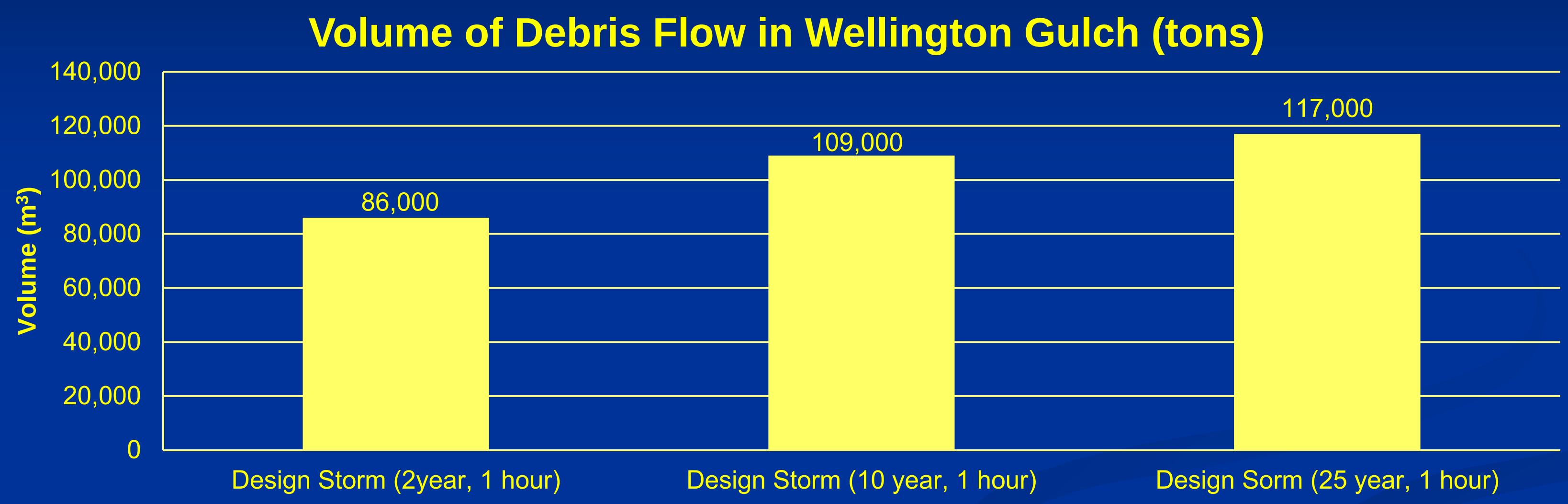
Wellington Gulch, FC-010,

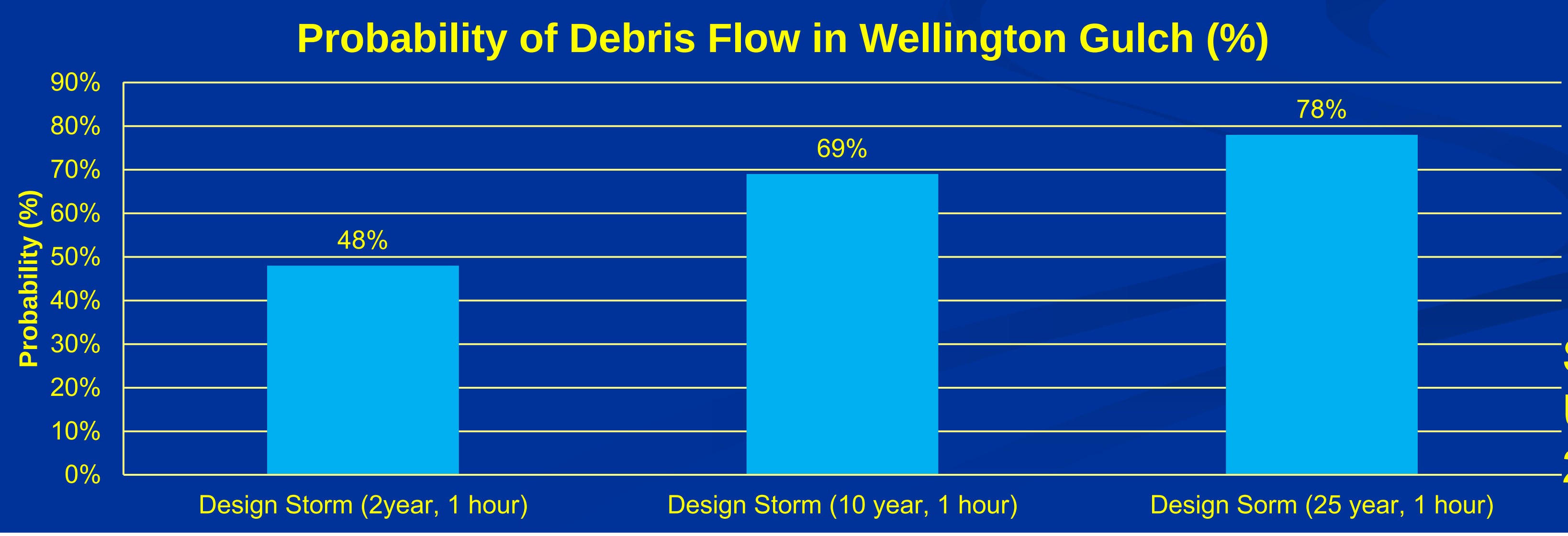
625 tons/yr (18%) Total Delivered Sediment from Hillslopes





Predicted Debris Flows in Wellington Gulch





Source: USGS, 2012

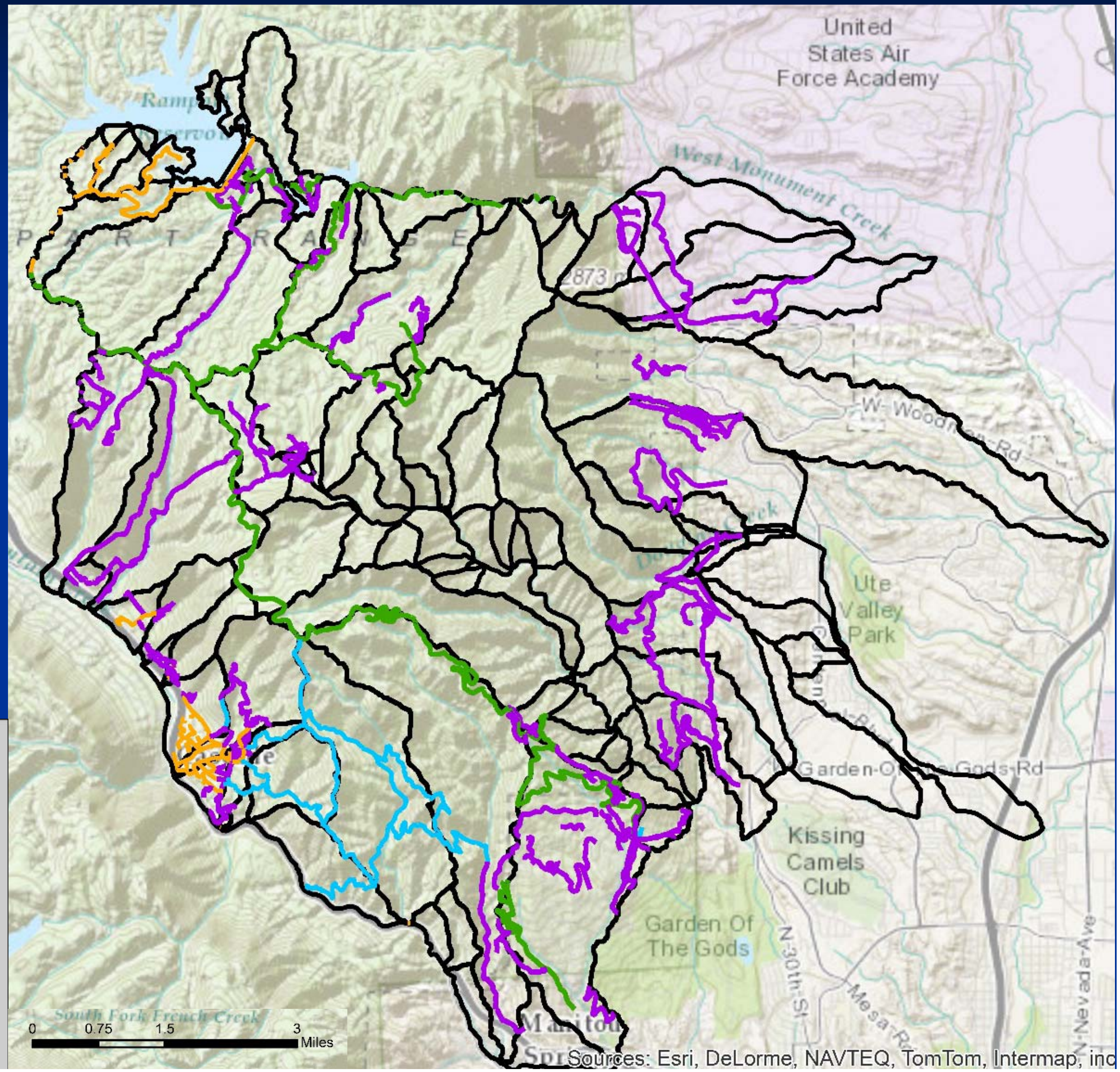
Roads & Trails

Roads & Trails

- Account for *2,035* tons/yr of Sediment (4% of Total Introduced Sediment)
  - ***Gravel Roads***
  - ***Dirt Roads***
  - **Paved Roads**
  - **Trails**

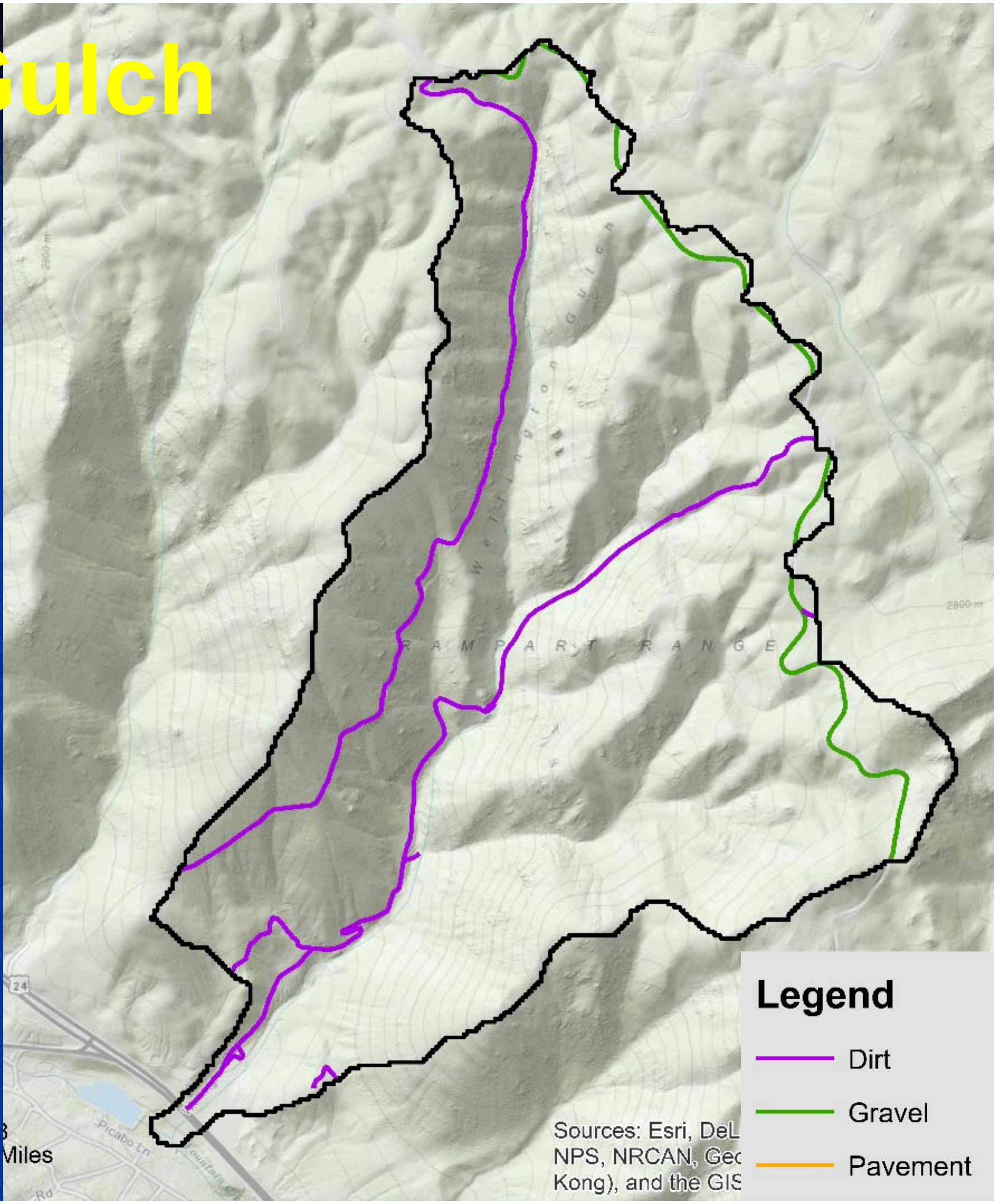
Roads & Trails

1. Camp Creek
   - 751 tons/yr
   - 37% of Total
2. Fountain Creek
   - 619 tons/yr
   - 30% of Total
3. West Monument
   - 429 tons/yr
   - 21% of Total
4. Douglas Creek
   - 236 tons/yr
   - 12% of Total



Wellington Gulch Roads

- 395 ton/yr (12%) of Total Introduced Sediment
  - 64% of Total Roads in the Fountain Creek Watershed



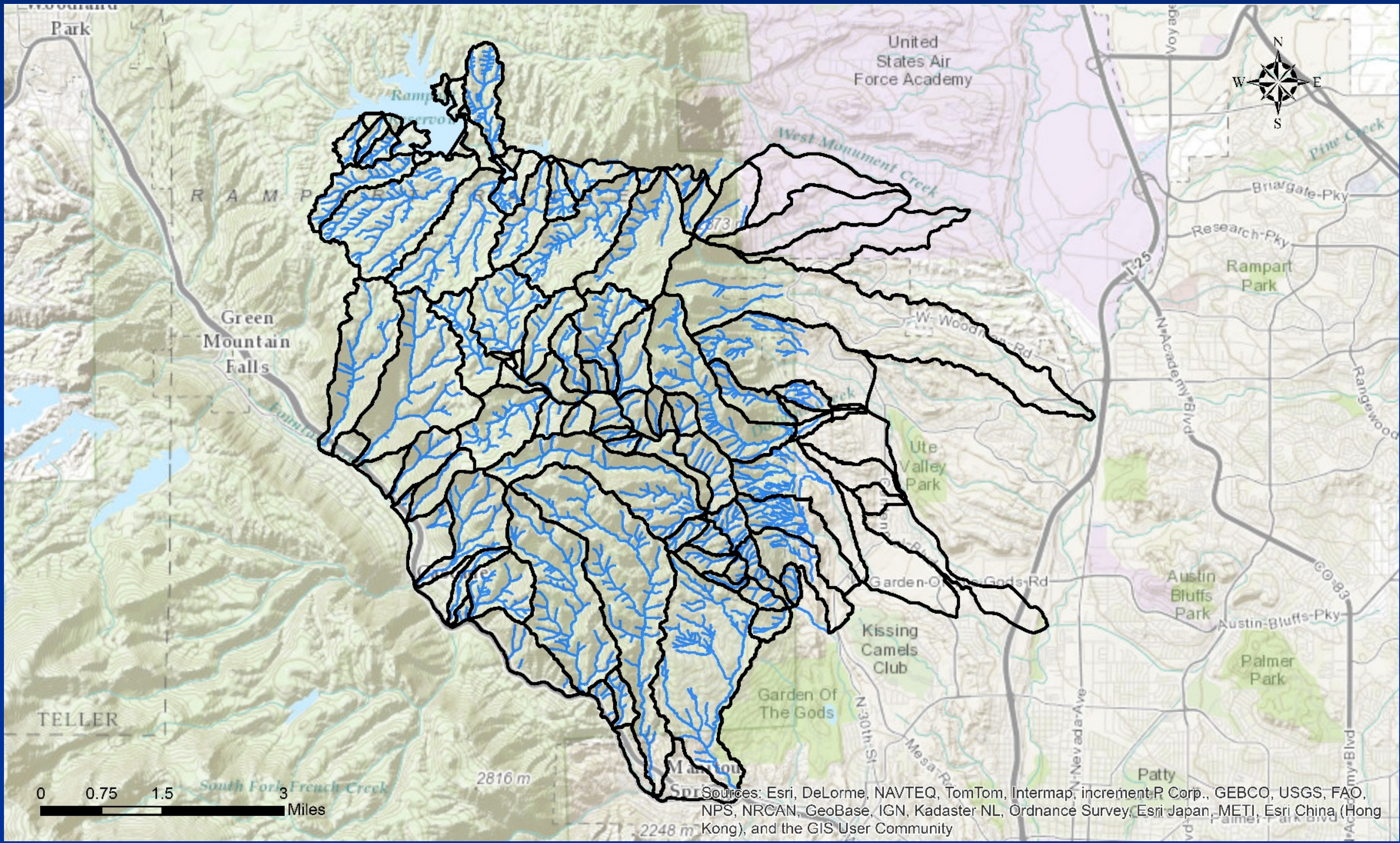

Streambank Erosion

Channel Processes:
Detailed Channel Stability Assessment

- ***Representative (Impaired) Reaches -*** represent all stream types and stability conditions existing in the watersheds

Representative (Impaired) – Stream Type Reach

Evaluated Streams



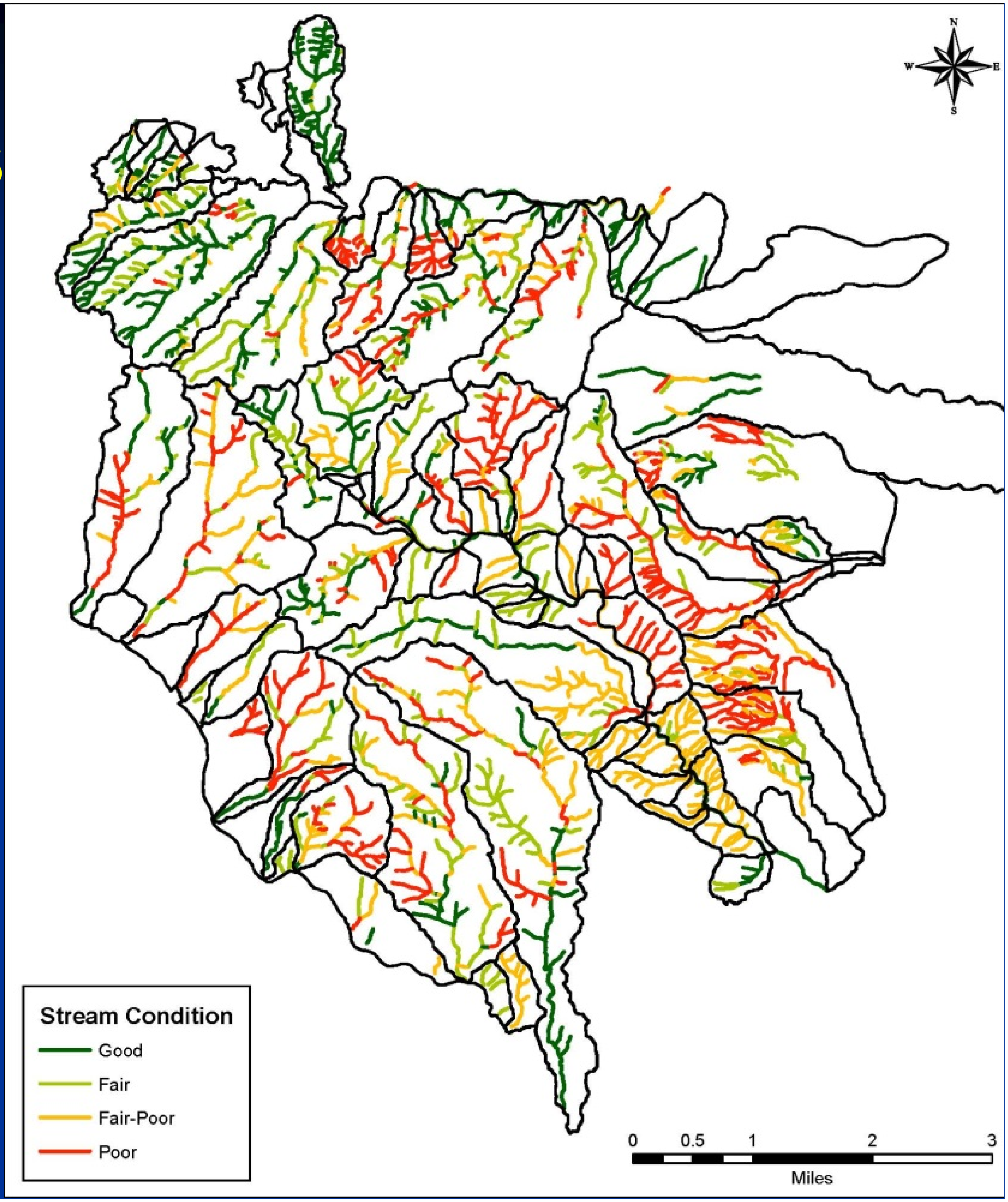
Channel Source Sediment

Streambank Erosion (BANCS Model)

- Accounts for *31,480* tons/yr of sediment from 237 miles of stream (61% of total introduced sediment)

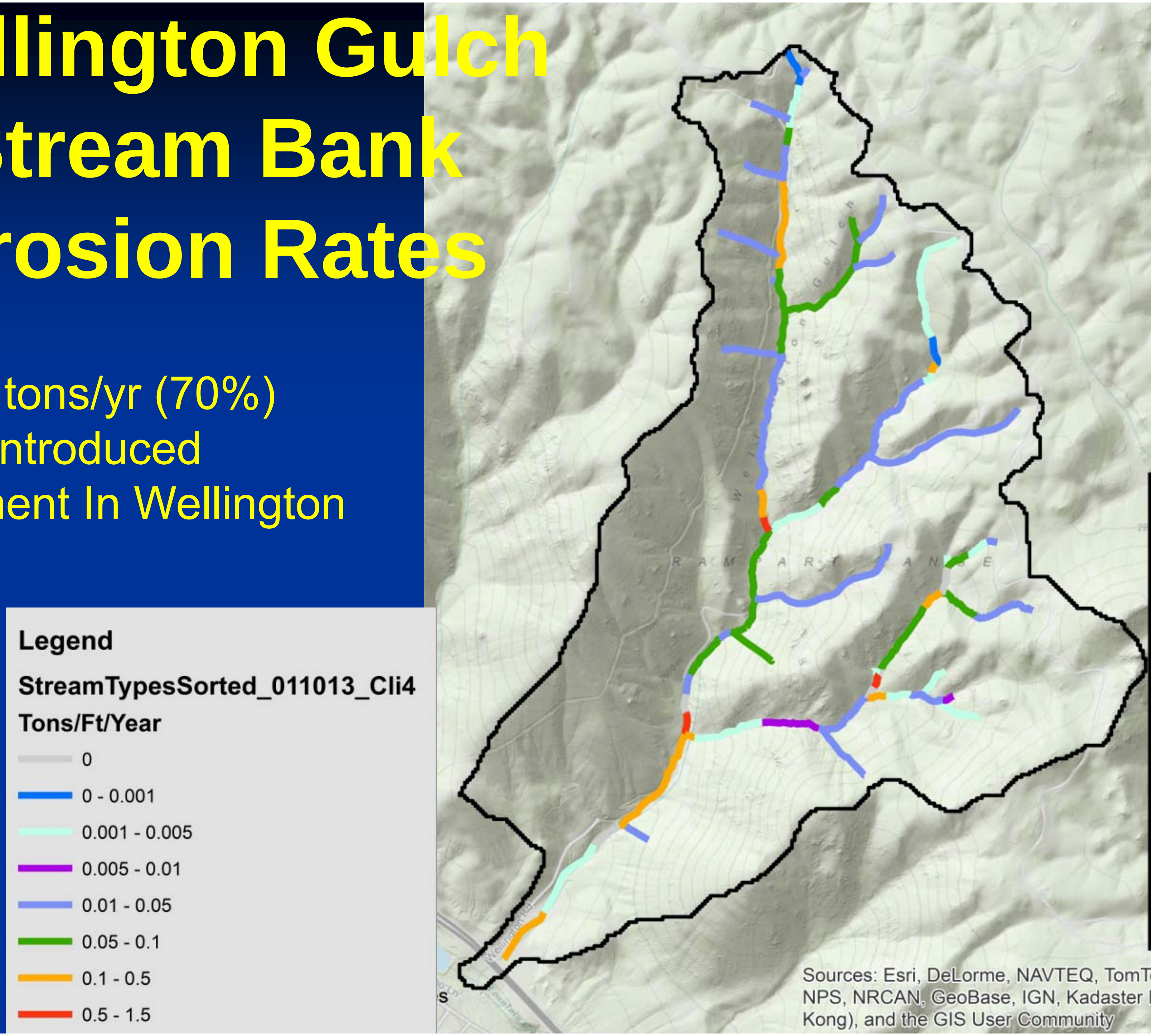
Stream Bank Erosion Rates

1. Fountain Creek
   - 11,318 tons/yr
   - 36%
2. West Monument
   - 7,183 tons/yr
   - 23%
3. Camp Creek
   - 6,750 tons/yr
   - 22%
4. Douglas Creek
   - 6,107 tons/yr
   - 19%

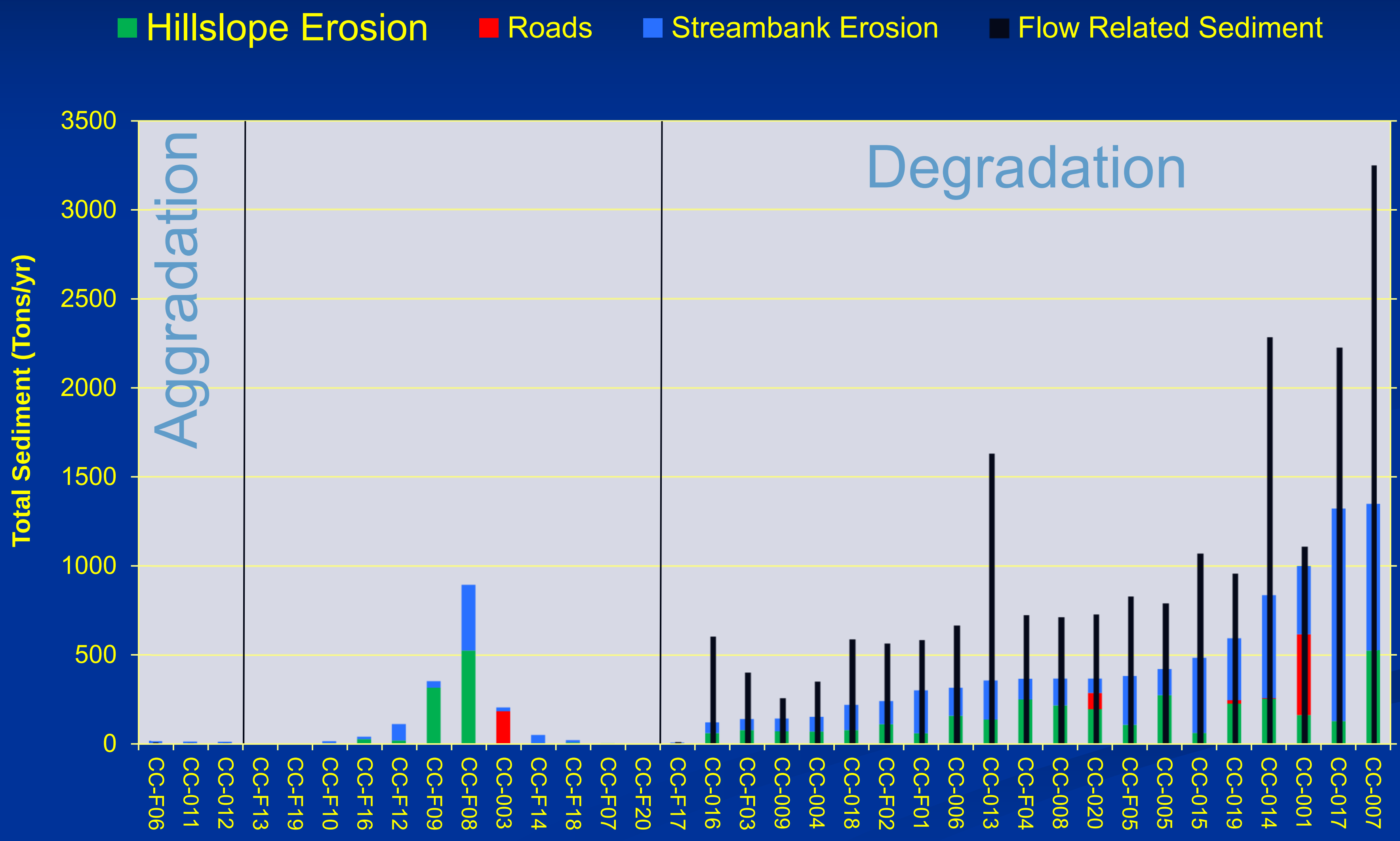


Wellington Gulch Stream Bank Erosion Rates

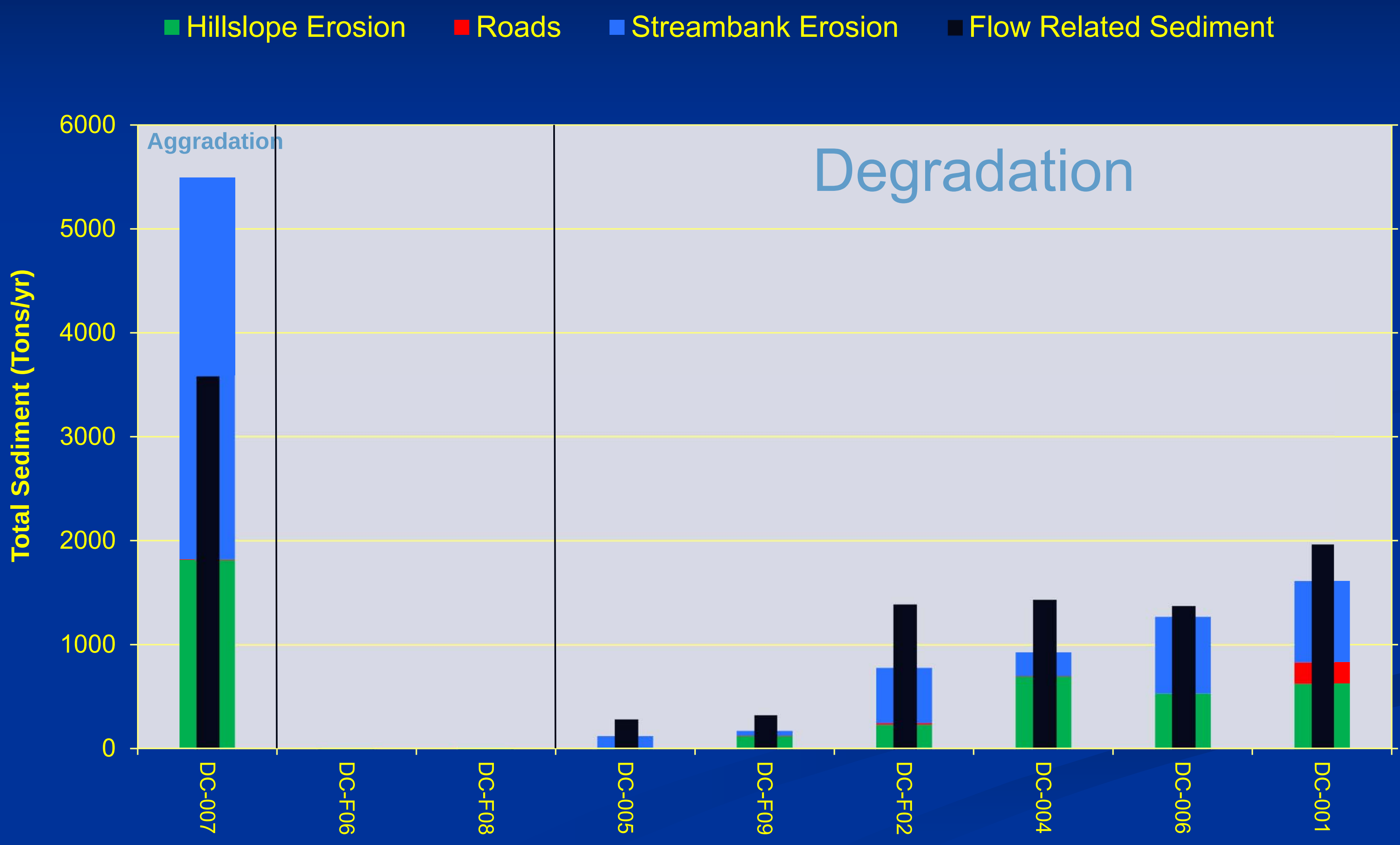
- 2,399 tons/yr (70%) Total Introduced Sediment In Wellington Gulch



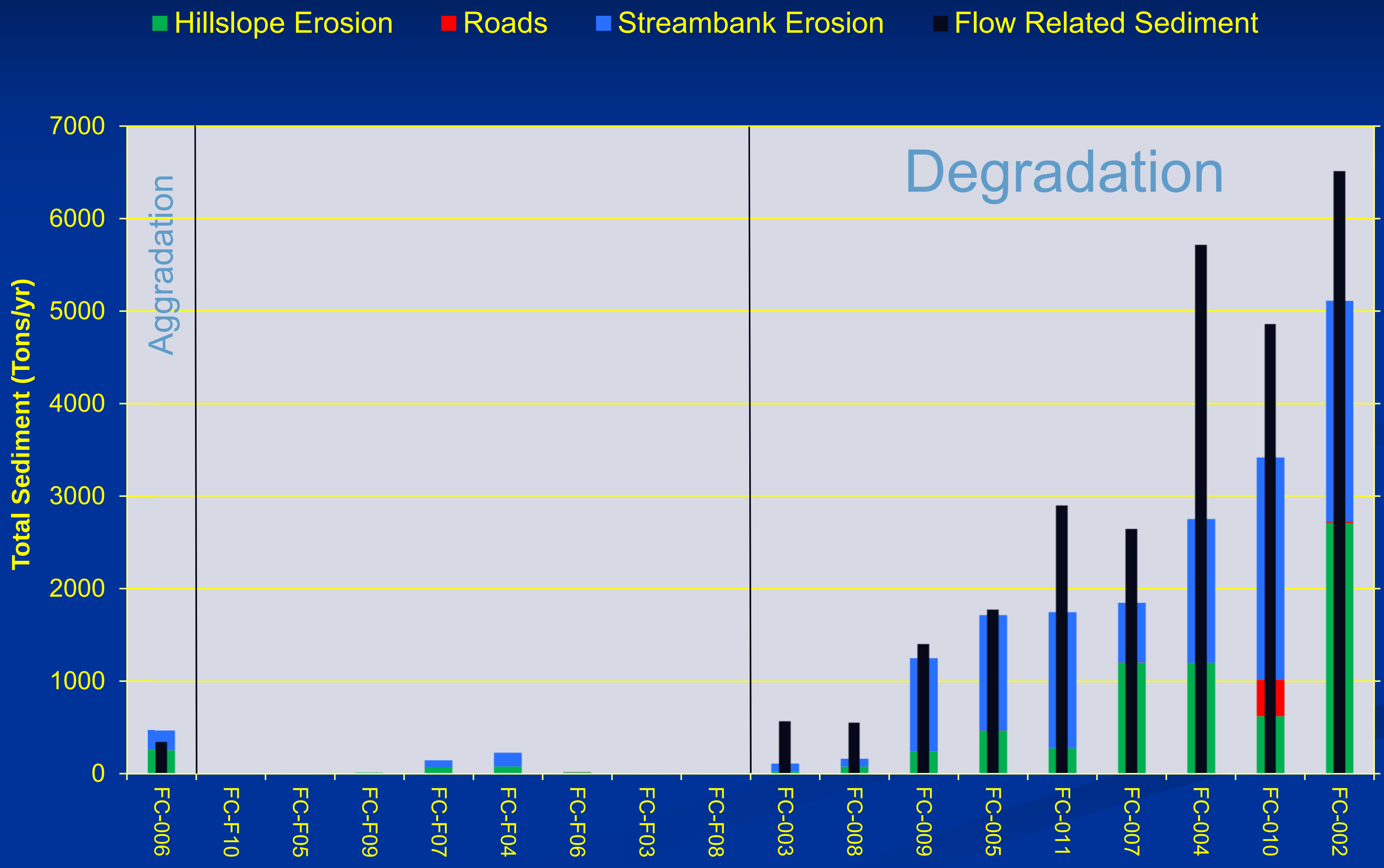
Sediment Summary: Camp Creek



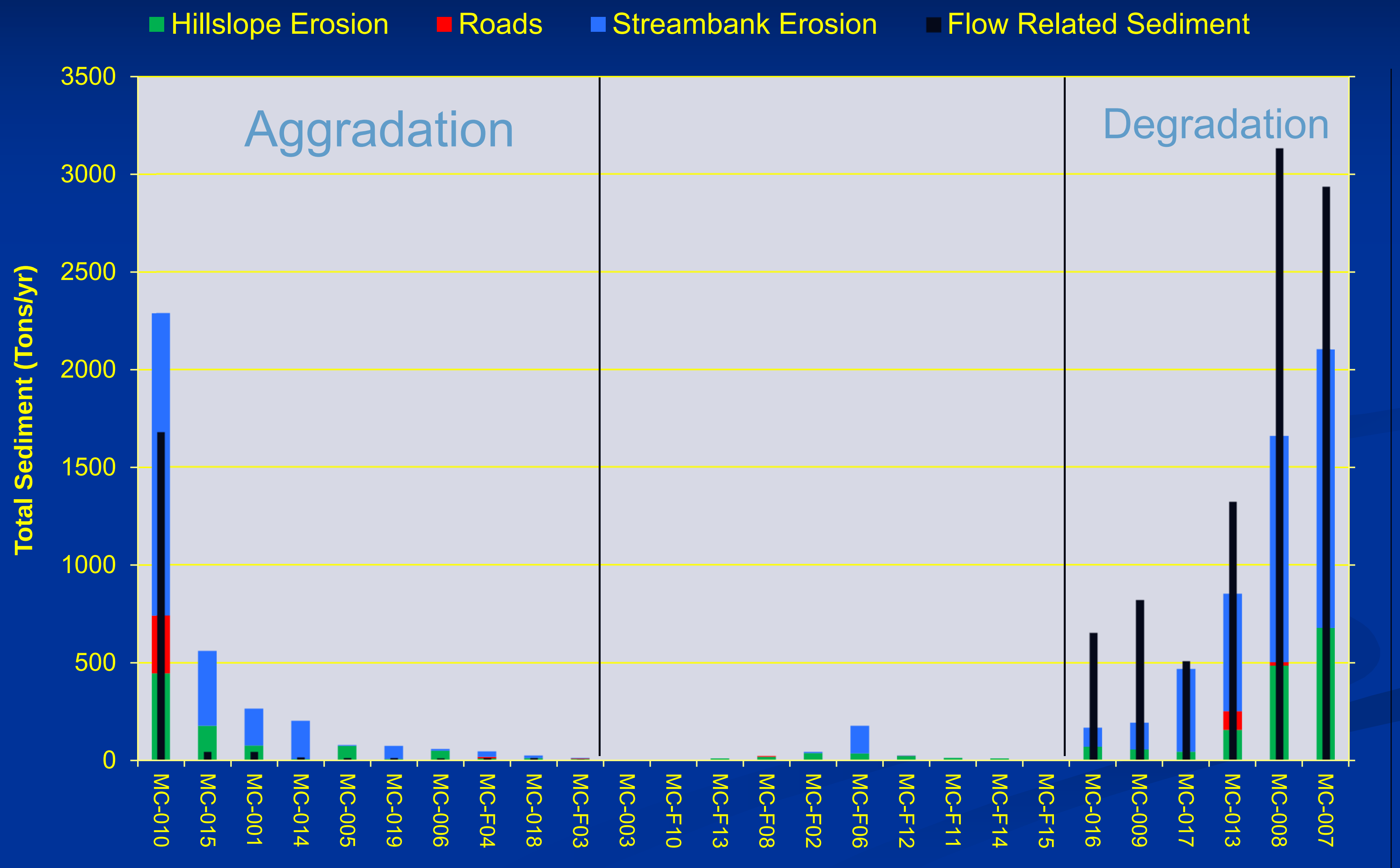
Sediment Summary: Douglas Creek



Sediment Summary: Fountain Creek

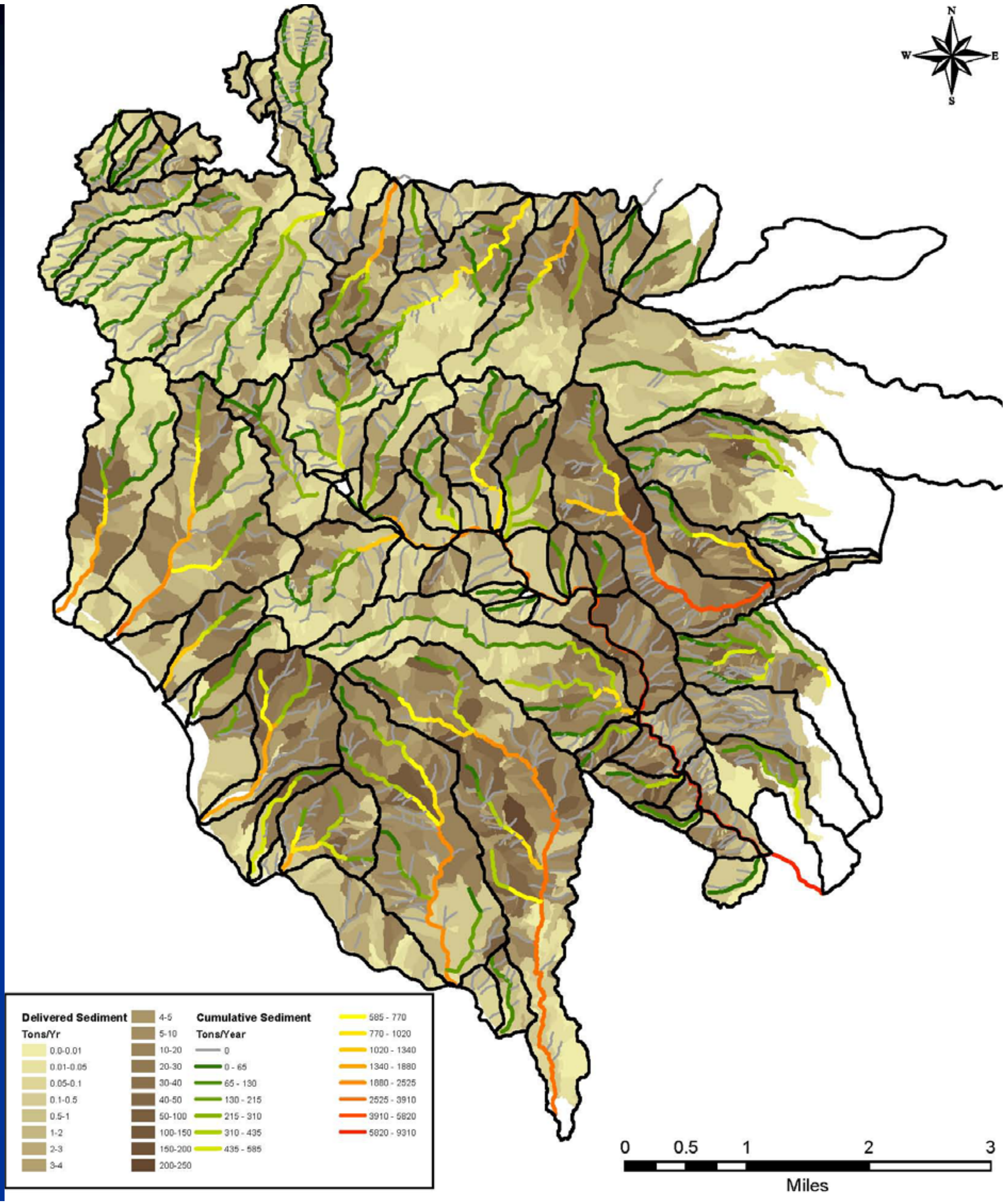


Sediment Summary: West Monument Creek



Cumulative Sediment Sources

1. Fountain Creek – 19,241 tons/yr
   - (37% of Total)
2. Camp Creek – 11,694 tons/yr
   - (23% of Total)
3. Douglas Creek – 10,401 tons/yr
   - (20% of Total)
4. West Monument – 10,143 tons/yr
   - (20% of Total)



What are the consequences of increased sediment supply? Won’t the floods “flush” the sediment?

Flood debris/aggradation under and over bridge-White River, Oregon

Aggradation of Coal Basin Creek under bridge, causing loss of flood capacity

5.8 ft. of sediment deposition in concrete box culvert-Trail Creek

Aggradation of channel on flood recession

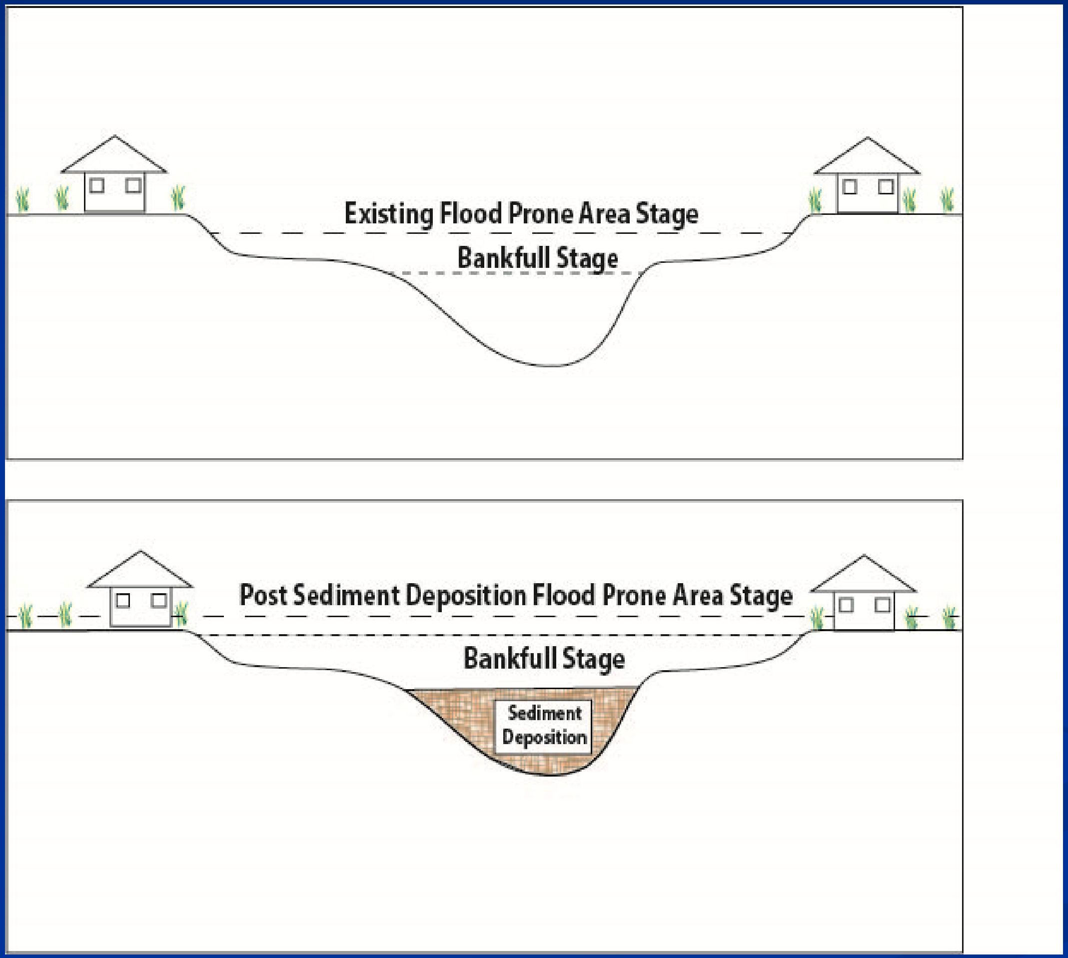
Excess sediment deposition from ¼ inch storm

Channel aggradation during flood adding to existing flood risks

Channel Process Impacts/Consequences

- Increased flood stage due to excess sediment
- Loss of riparian vegetation and flow resistance
- Land loss / property damage due to streambank erosion and lateral adjustment
- Long term instability and loss of function

Flood stage change due to sediment deposition



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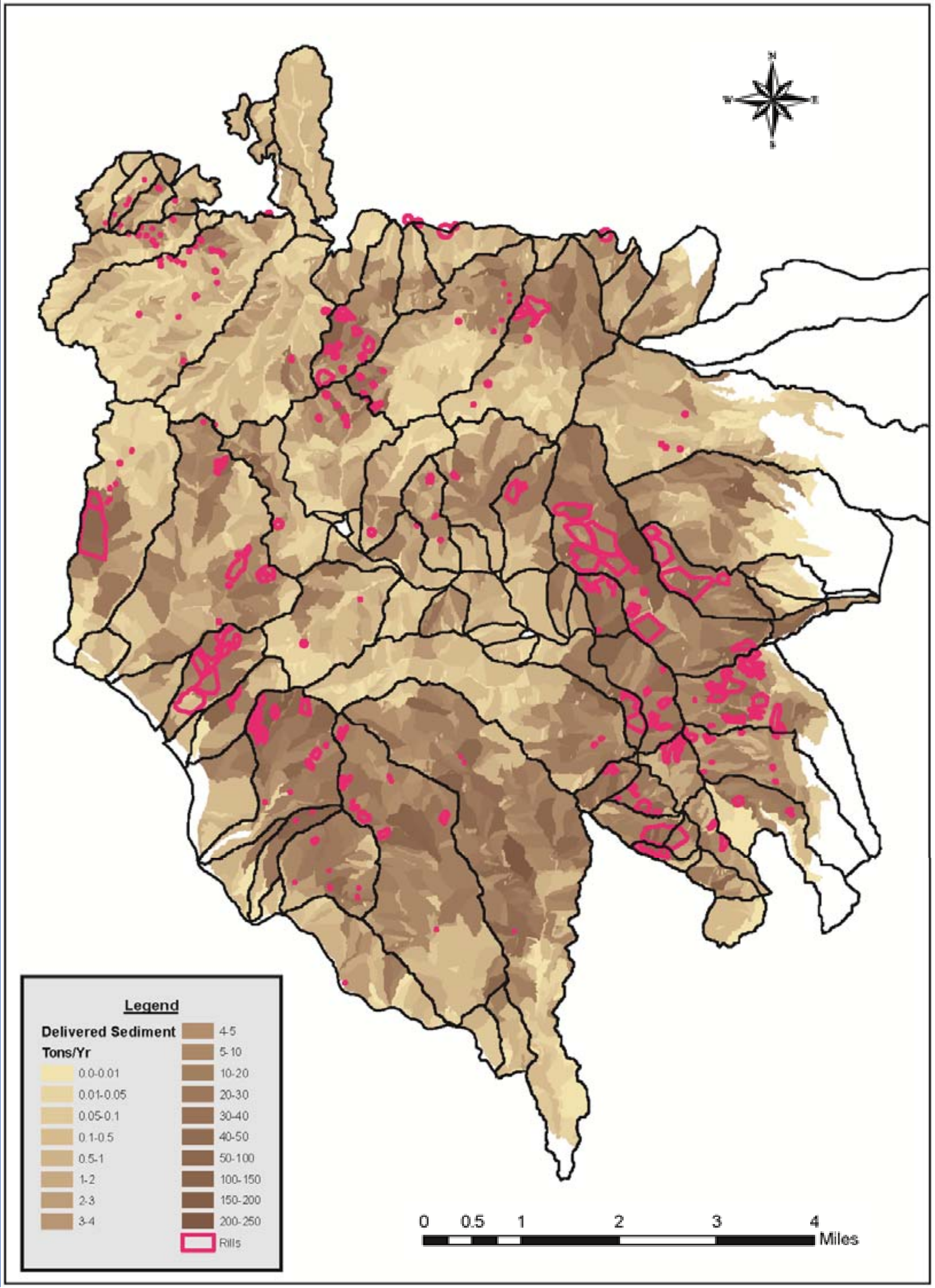
Distribution of Delivered Sediment from Hillslopes and Rill Location

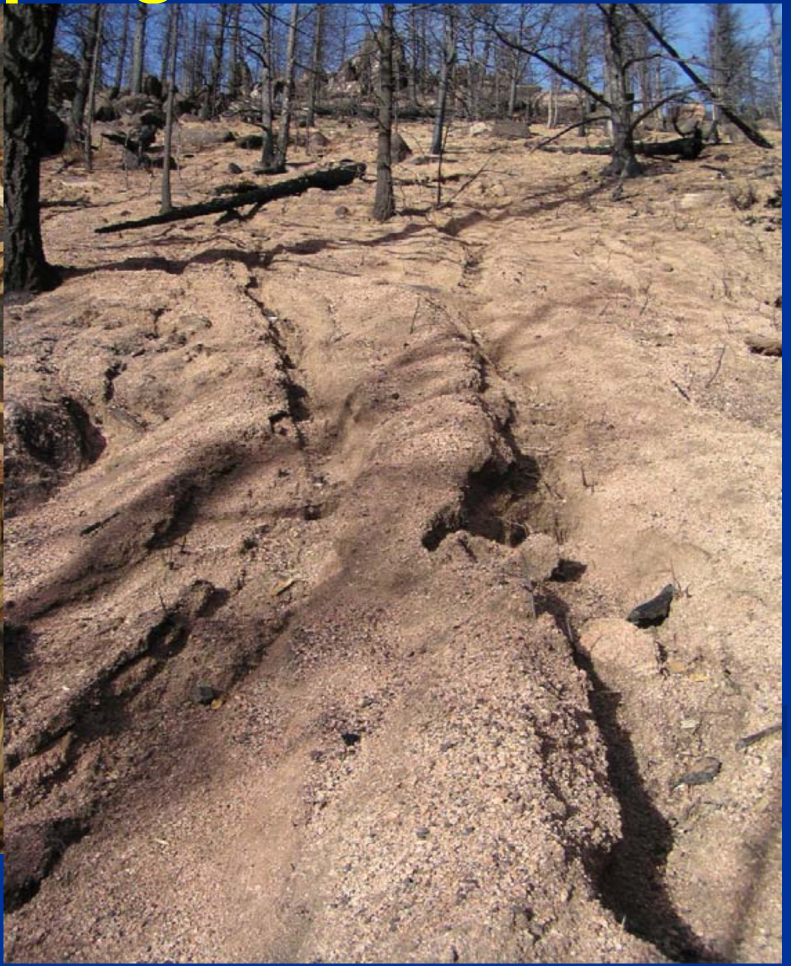


Design Solutions:
Hillslope Objectives

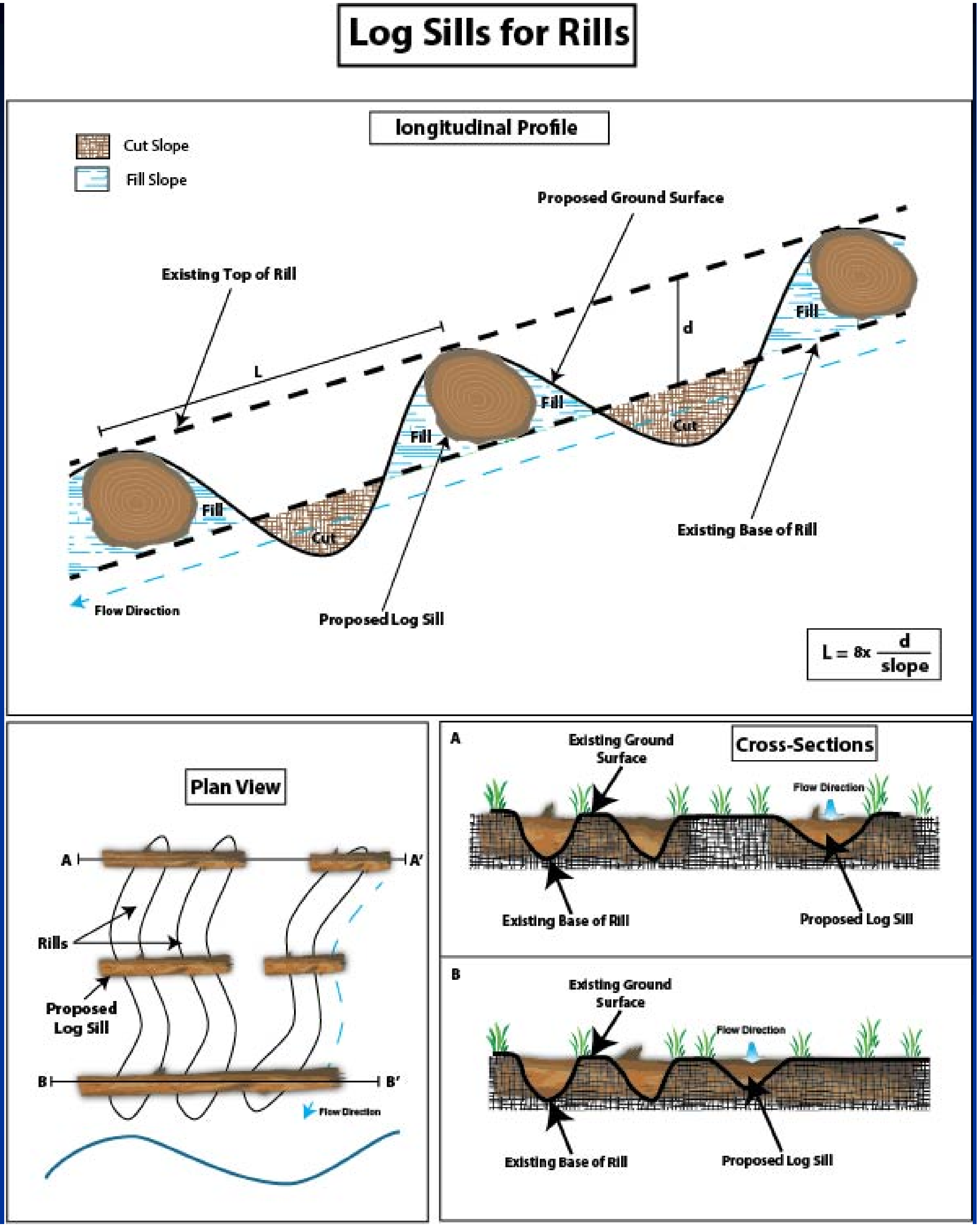
- Increase time of concentration (increase infiltration)
- Reduce surface erosion processes:
    - Raindrop impact
    - Particle detachment
    - Overland flow
- Reduce sediment delivery

Design Solutions:

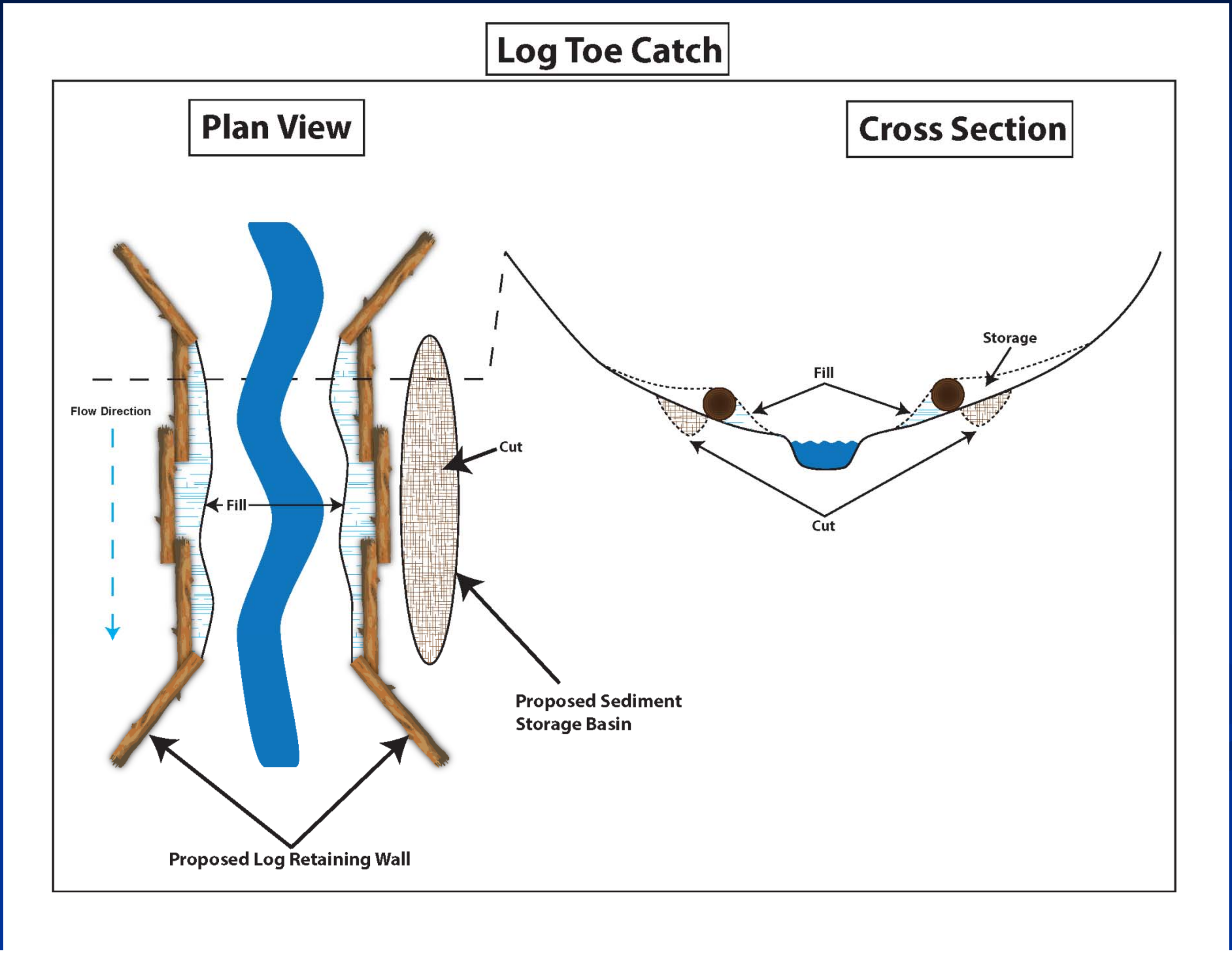
Hillslope-Increase ground cover add surface roughness, seed and mulch and discontinuously plug rills



Design Solutions: Hillslope



Design Solutions: Hillslope



Design Solutions: Hillslope Erosion

Hillslope Issue	Mitigation Techniques	Hand or Mechanical	Surface Roghness	Surface Protection	Flow Dispersion	Grade Control
Rills	Sills	H			✓	✓
	Plugs	H	✓		✓	✓
	Discontinuity	H			✓	
Ground Cover	Mulch	H or M	✓	✓	✓	
	Seeding	H or M	✓	✓	✓	
	Tree Plugs	H	✓	✓	✓	
Direct Routing	Toe Catch	H or M			✓	✓
	Bankfull Bench	M			✓	✓

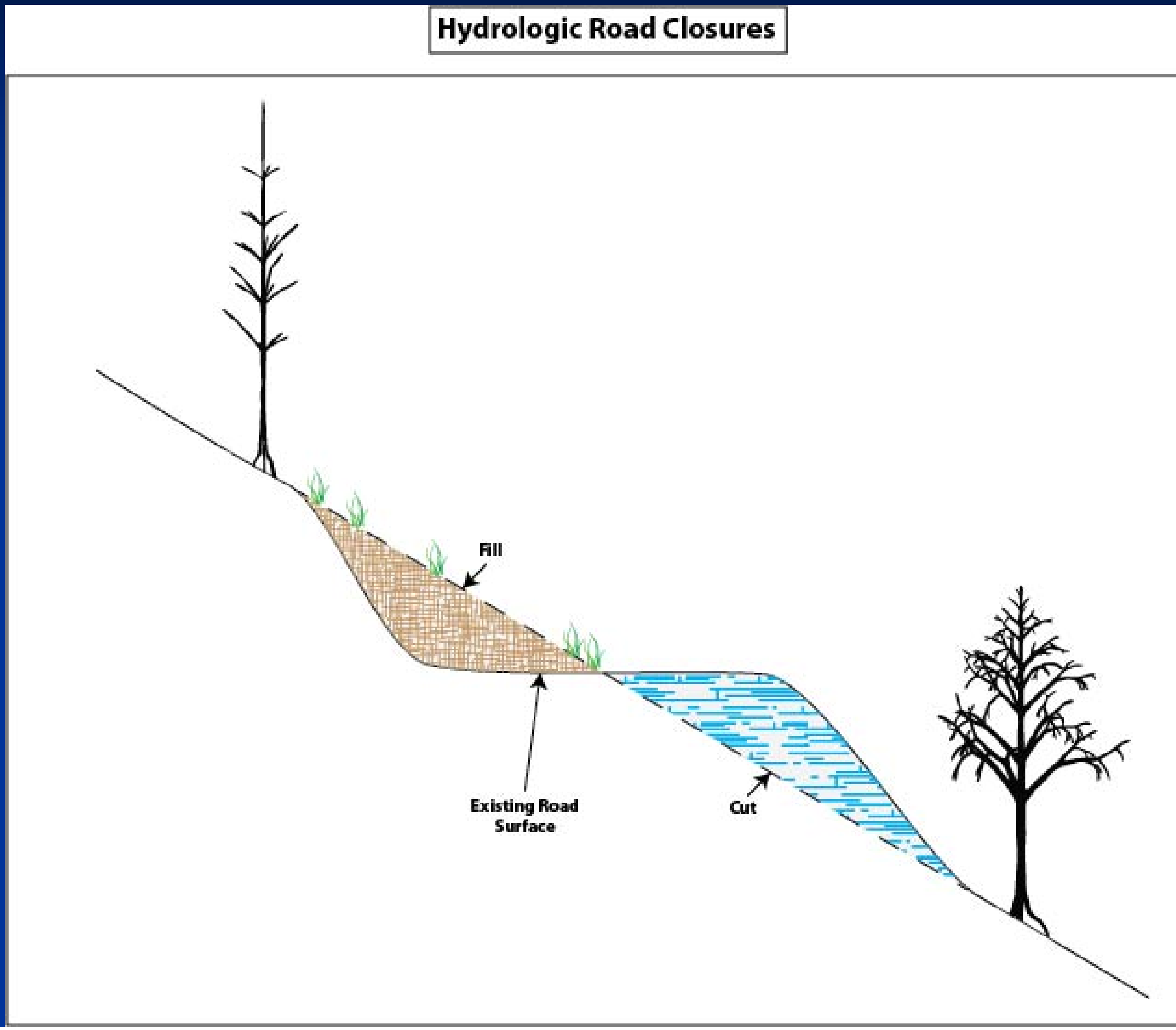
Design Objectives: *Roads*

- Reduce sediment delivery from roads
- Reduce streamflow increases due to roads

Design Solutions: *Roads*

- Drain roads frequently
- Dissipate flow below culverts
- Stabilize conveyance channels below road drainages
- Address unauthorized road usage
- Relocate high risk roads
- Stabilize decommissioned roads

Design Solutions: Roads



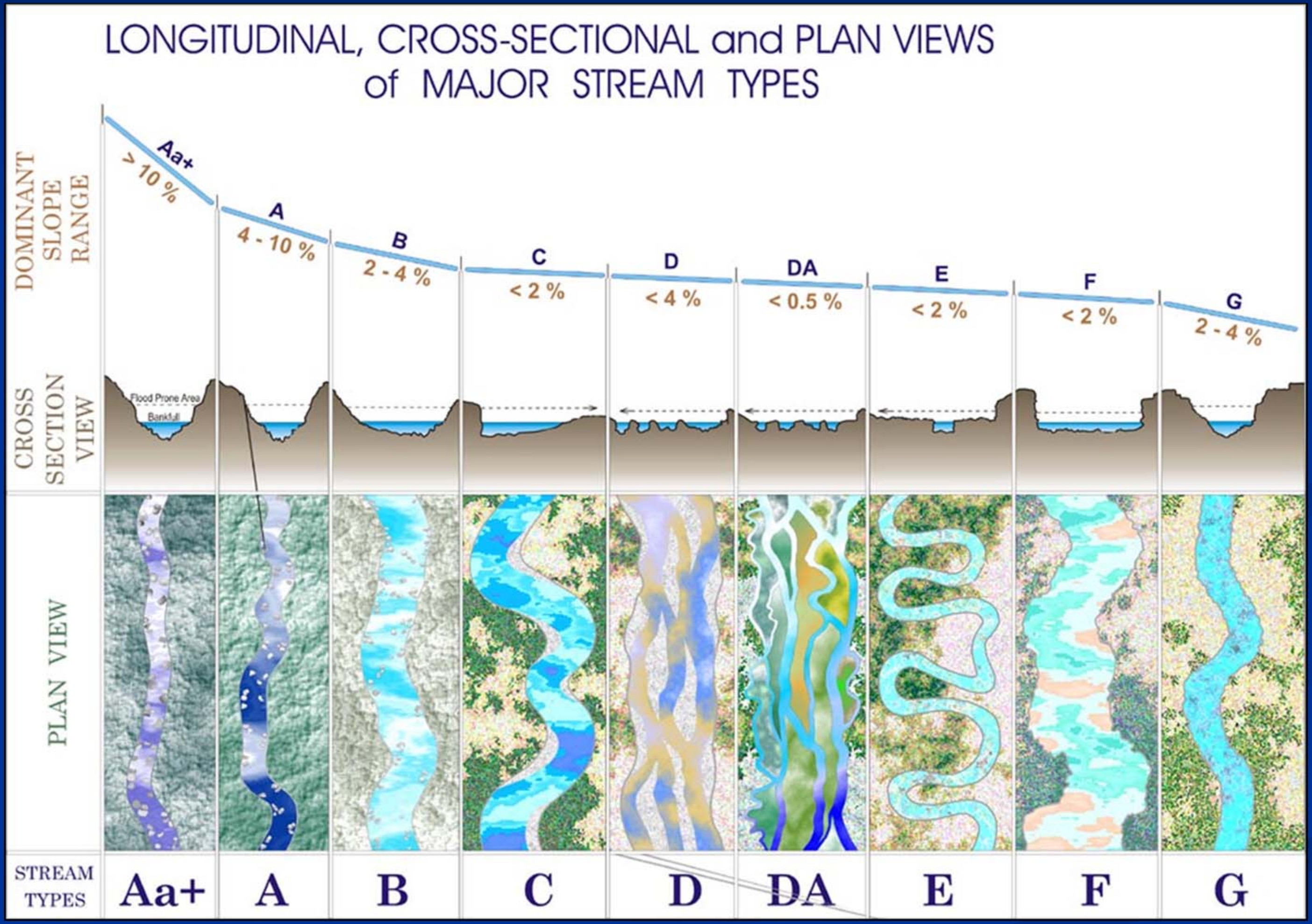
Channel Restoration Process Objectives:

- Increase natural sediment storage
- Reduce streambank erosion
- Reduce channel incision
- Dampen flood peaks
- Re-establish riparian function
- Re-establish channel connectivity
- Establish a natural stable channel

Channel Restoration Process

- Determine the natural, stable stream type appropriate for the valley type/landform
- Develop design scenarios based on existing stream type, condition and valley parameters
- Utilize native materials for stabilization
- Disperse flow energy by re-connecting incised channels to floodplains/alluvial fans
- Provide sediment storage where appropriate

Broad Level Stream Types

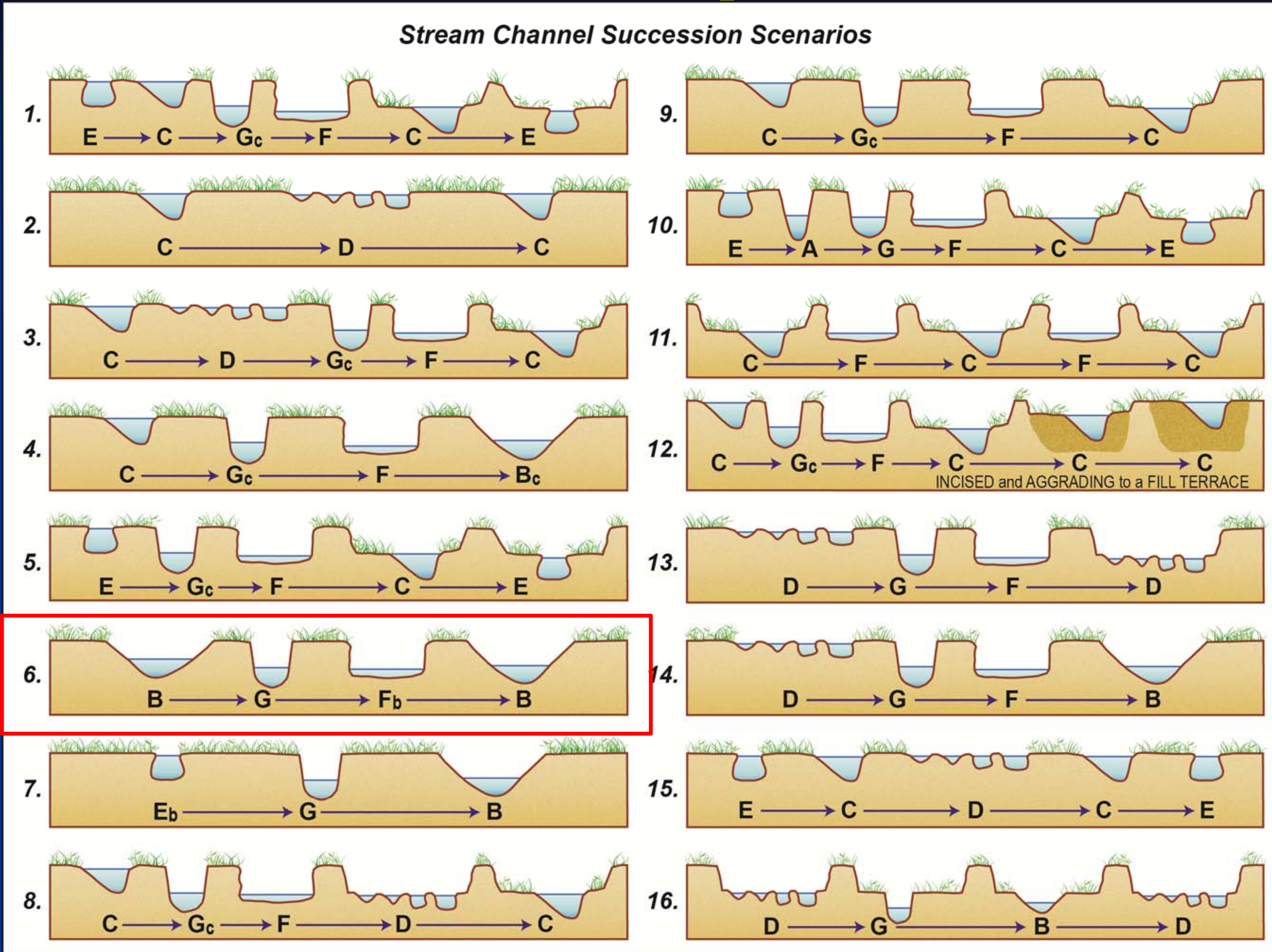


Channel Processes:
Detailed Channel Stability Assessment

- ***Reference (Stable) Reaches -*** Used for departure analysis of impaired reaches and in natural channel design process

Reference Reach – B4 Stream Type- West Monument Creek

Central Tendency of Rivers:



Design Solutions: Channel Processes

- Developed ***Eight Typical Design Scenarios***: Representative of the conditions present in watershed

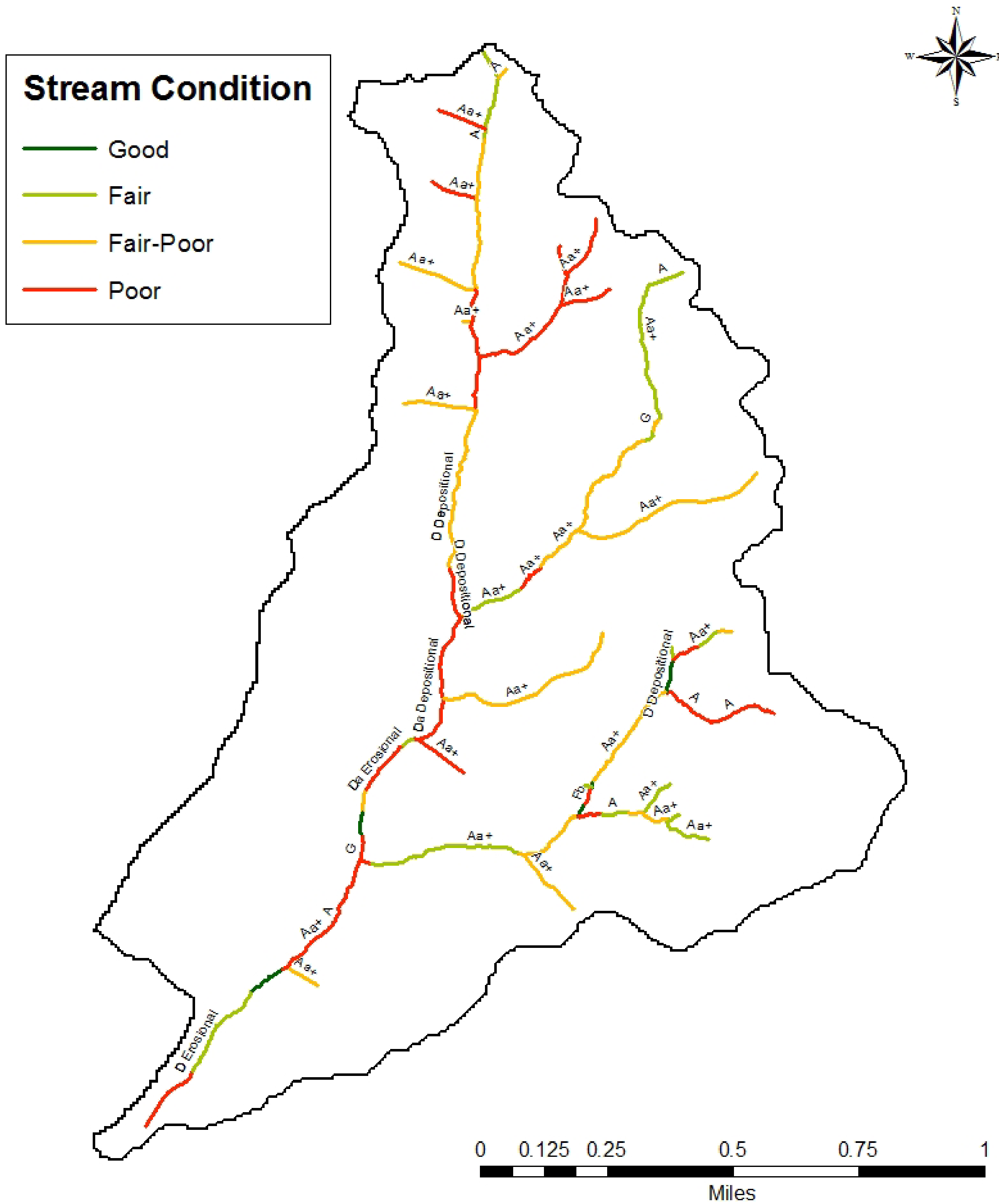
Mechanical

Typical Design Scenarios				
Existing, Impaired Stream Type		**Existing Condition**	**Proposed, Stable Stream Type**	**Valley Type (VT)**
1.	D4	Poor	C4	VIII
2.	F4	Poor	B4c	II, III, VIIIa,b
3.	G4	Poor	B4	II, III, VIIIa,b
4.	C4	Poor	C4	VIIIa,b,c
5.	A4, Aa+, Fb F4 and G4	Poor	D4 / D4a	II, III, VIII
6.	F4b	Poor	B4	II, III, VIIIa,b
7.	A4 or A4a+	Poor	A4 or A4a+	II, III, VIIIa,b
8.	A4 or Aa+	Poor	B4a	II, IIIa,b, VIIIa,b

Design Scenario Components:

- General Description & Morphological Data
- Bankfull Discharge, Area & Velocity
- Plan View Alignment
- Cross-Section Dimensions
- Longitudinal Profile
- Structures & Riparian Vegetation
- Cut & Fill Computations
- Streambank Erosion
- Flow-Related Sediment & Competence

Stream Type and Condition for Wellington Gulch



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4.	C4	Poor	C4	VIIIa,b,c
5.	A4, Aa+, Fb F4 and G4	Poor	D4 / D4a	II, III, VIII
6.	F4b	Poor	B4	II, III, VIIIa,b
7.	A4 or A4a+	Poor	A4 or A4a+	II, III, VIIIa,b
8.	A4 or Aa+	Poor	B4a	II, IIIa,b, VIIIa,b

Design Scenario 1: D4 To C4

Design Scenario 1: D4 To C4

- **Transports 84% More Sediment**
- **Reduced Flood Stage Approximately 3ft**

Design Solutions: Channel Processes

- Developed ***Eight Typical Design Scenarios***: Representative of the conditions present in watershed

Mechanical

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	Existing, Impaired Stream Type	Existing Condition	Proposed, Stable Stream Type	Valley Type (VT)
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3.	G4	Poor	B4	II, III, VIIIa,b
4.	C4	Poor	C4	VIIIa,b,c
5.	A4, Aa+, Fb F4 and G4	Poor	D4 / D4a	II, III, VIII
6.	F4b	Poor	B4	II, III, VIIIa,b
7.	A4 or A4a+	Poor	A4 or A4a+	II, III, VIIIa,b
8.	A4 or Aa+	Poor	B4a	II, IIIa,b, VIIIa,b

Design Scenario 2: F4 To B4c

Design Scenario 2: F4 To B4c

- **Reduces Bank Erosion 465 tons/yr per 1,000ft of channel**
- **81% More Efficient (Reduced Risk of Aggradation)**
- **Increased Flood Capacity**

Design Solutions: Channel Processes

- Developed ***Eight Typical Design Scenarios***: Representative of the conditions present in watershed

Mechanical

Typical Design Scenarios				
Existing, Impaired Stream Type		Existing Condition	Proposed, Stable Stream Type	Valley Type (VT)
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3.	G4	Poor	B4	II, III, VIIIa,b
4.	C4	Poor	C4	VIIIa,b,c
5.	A4, Aa+, Fb F4 and G4	Poor	D4 / D4a	II, III, VIII
6.	F4b	Poor	B4	II, III, VIIIa,b
7.	A4 or A4a+	Poor	A4 or A4a+	II, III, VIIIa,b
8.	A4 or Aa+	Poor	B4a	II, IIIa,b, VIIIa,b

Design Scenario 3: G4 To B4

Design Scenario 3: G4 To B4

- **Reduces Bank Erosion 655 tons/yr per 1,000ft of channel**
- **Reduces Risk of Down-Cutting**
- **Increases Flood Capacity**

Design Solutions: Channel Processes

- Developed ***Eight Typical Design Scenarios***: Representative of the conditions present in watershed

Mechanical

Typical Design Scenarios				
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4.	C4	Poor	C4	VIIIa,b,c
5.	A4, Aa+, Fb F4 and G4	Poor	D4 / D4a	II, III, VIII
6.	F4b	Poor	B4	II, III, VIIIa,b
7.	A4 or A4a+	Poor	A4 or A4a+	II, III, VIIIa,b
8.	A4 or Aa+	Poor	B4a	II, IIIa,b, VIIIa,b

Design Scenario 4: C4 To C4

Design Scenario 4: C4 To C4

- **Reduces Bank Erosion 40.7 tons/yr per 1,000ft of channel**
- **85% More Efficient (Reduced Risk of Aggradation)**

Design Solutions: Channel Processes

- Developed ***Eight Typical Design Scenarios***: Representative of the conditions present in watershed

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4.	C4	Poor	C4	VIIIa,b,c
5.	A4, Aa+, Fb F4 and G4	Poor	D4 / D4a	II, III, VIII
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7.	A4 or A4a+	Poor	A4 or A4a+	II, III, VIIIa,b
8.	A4 or Aa+	Poor	B4a	II, IIIa,b, VIIIa,b

Design Scenario 5: F To D

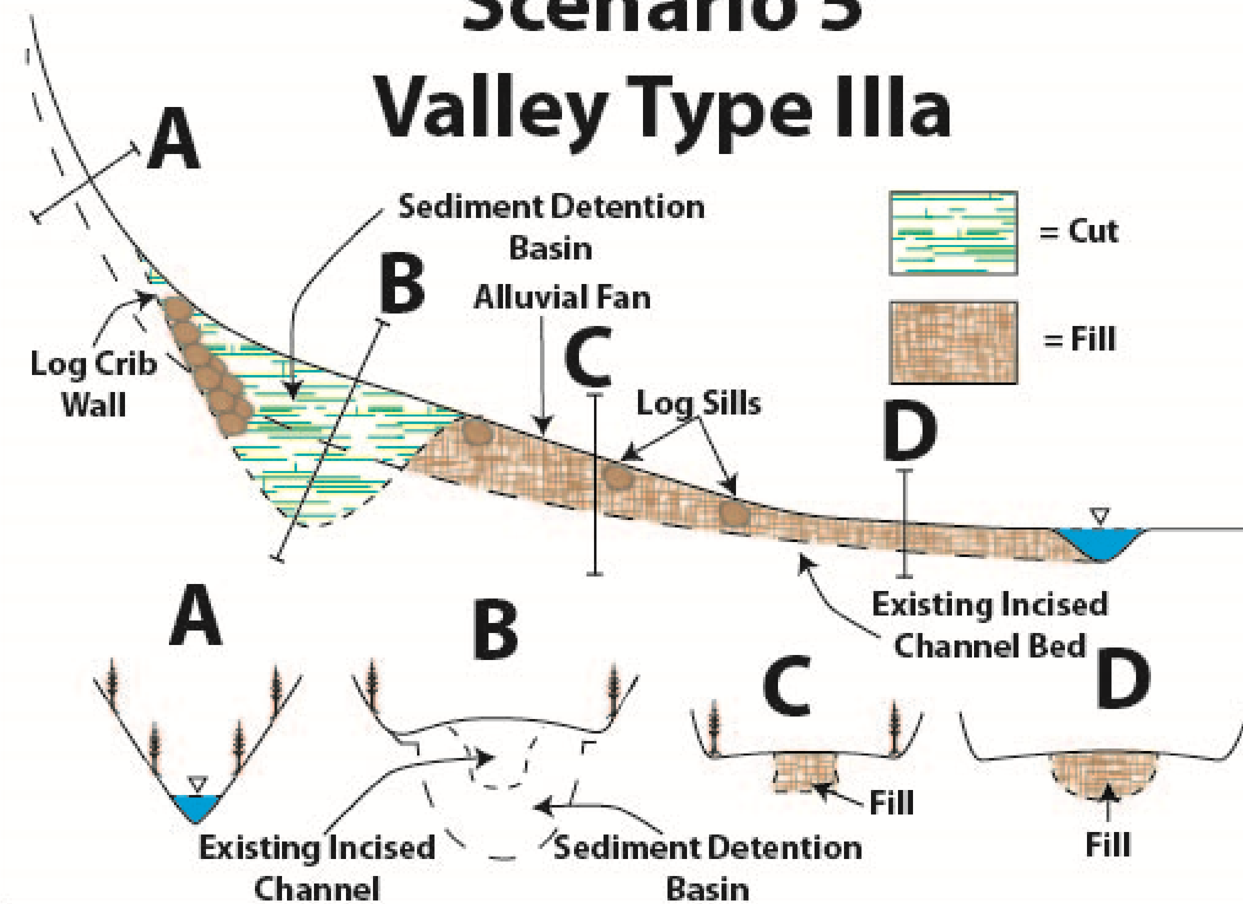
Design Scenario 5: F To D

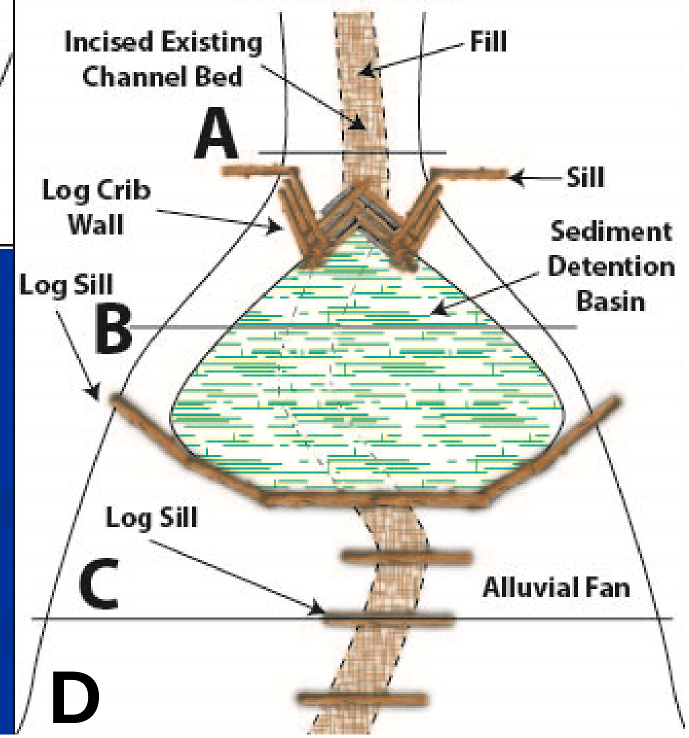
Design Scenario 5: F To D

- Approximately 15,600 Tons of Storage (5 Basins)
- Attenuates Flood Flows

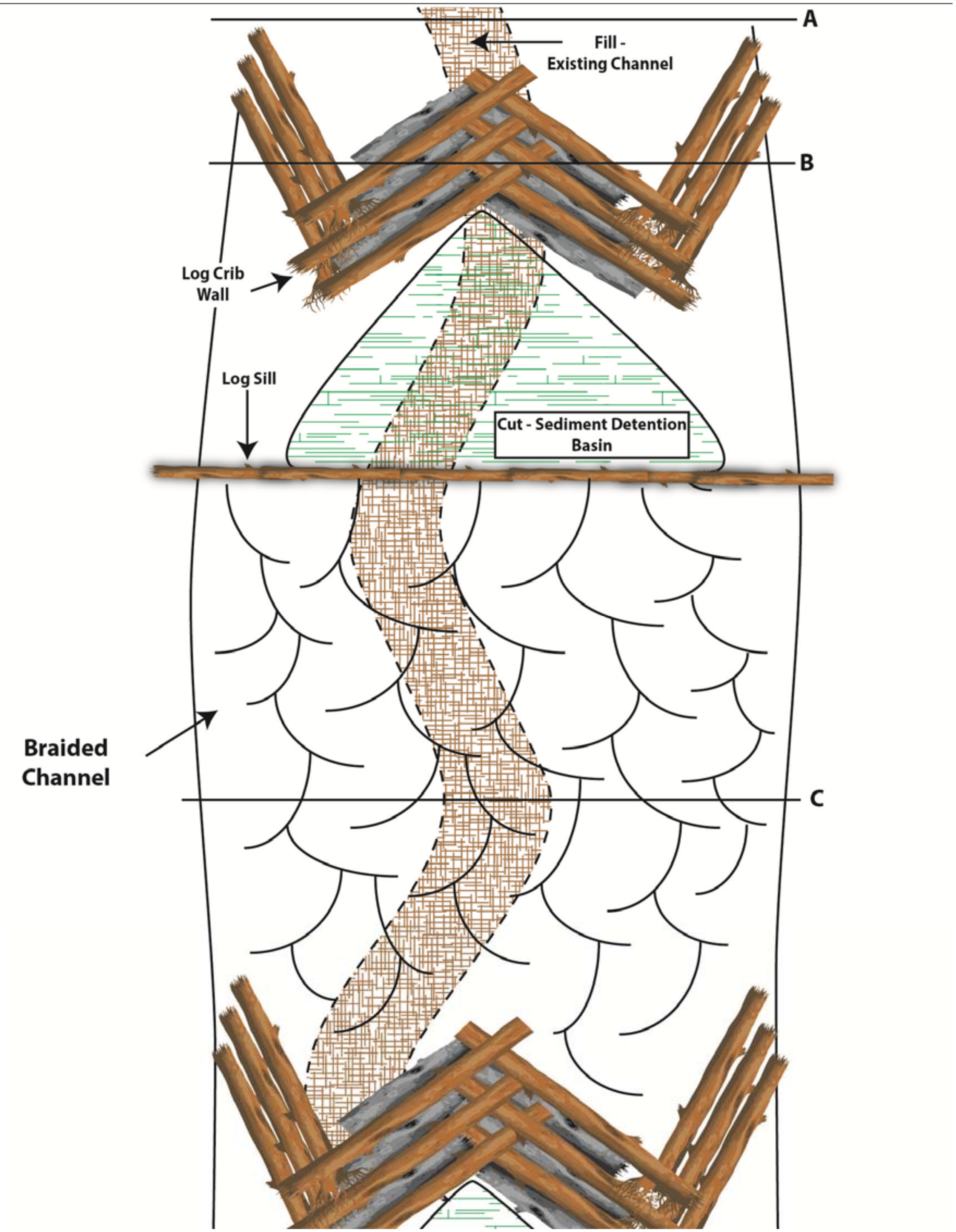
Design Scenario 5: F To D

Scenario 5
Valley Type IIIa

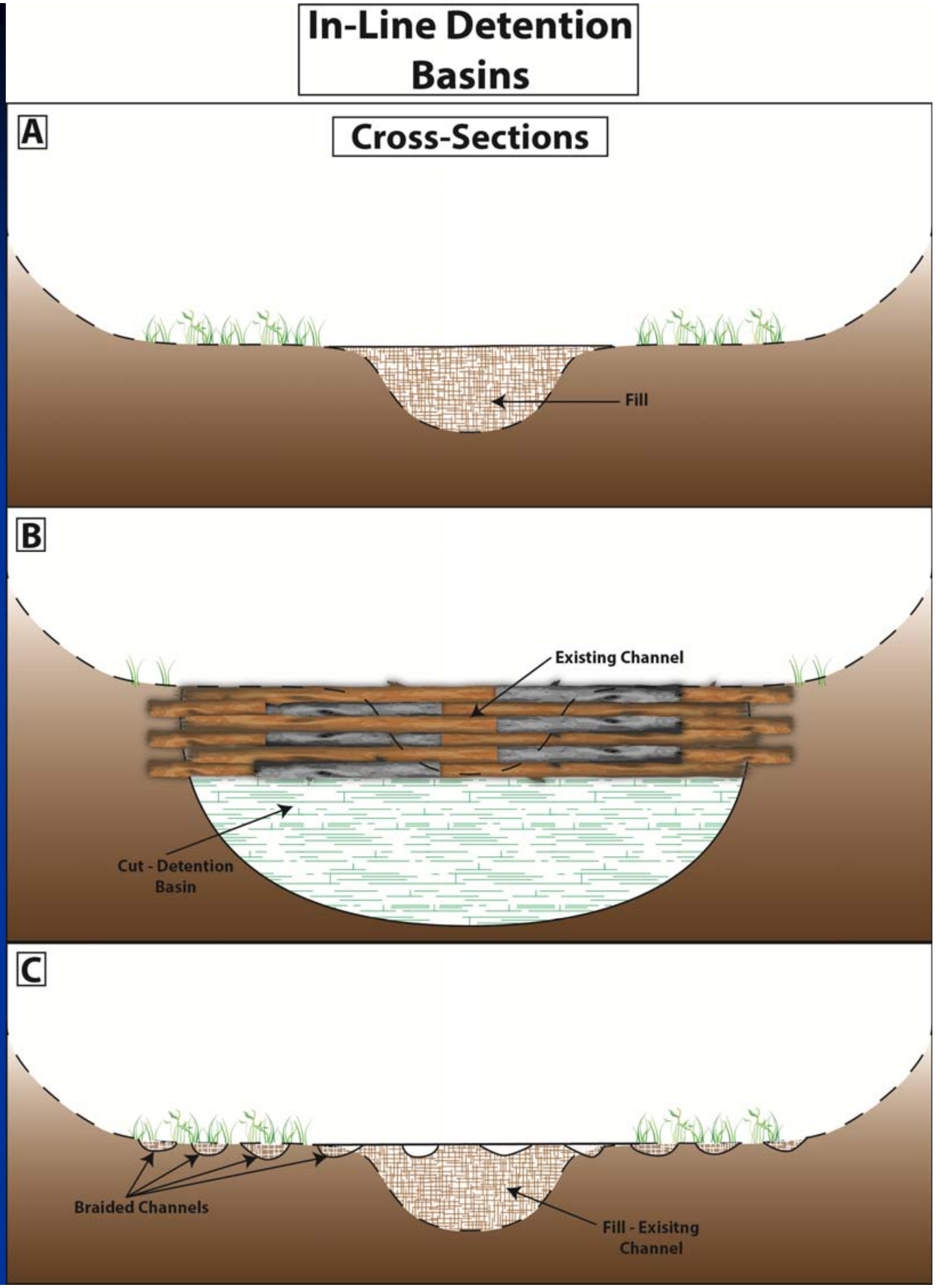




Design Scenario 5: F To D



Design Scenario 5: F To D



Design Scenario 5: G To D

Design Scenario 5: G To D

Sediment detention basin-Trail Creek watershed

- Approximately 43,000 Tons of Storage

Alluvial fan reconnection with gully fill to disperse flows, induce infiltration and log placement to prevent rill development

Design Solutions: Channel Processes

- Developed ***Eight Typical Design Scenarios***: Representative of the conditions present in watershed

Mechanical

Typical Design Scenarios				
Existing, Impaired Stream Type		Existing Condition	Proposed, Stable Stream Type	Valley Type (VT)
1.	D4	Poor	C4	VIII
2.	F4	Poor	B4c	II, III, VIIIa,b
3.	G4	Poor	B4	II, III, VIIIa,b
4.	C4	Poor	C4	VIIIa,b,c
5.	A4, Aa+, Fb F4 and G4	Poor	D4 / D4a	II, III, VIII
6.	F4b	Poor	B4	II, III, VIIIa,b
7.	A4 or A4a+	Poor	A4 or A4a+	II, III, VIIIa,b
8.	A4 or Aa+	Poor	B4a	II, IIIa,b, VIIIa,b

Design Scenario 6: F4b To B4

Design Scenario 6: F4b To B4

- **Reduces Bank Erosion 465 tons/yr per 1,000ft of channel**
- **81% More Efficient (Reduced Risk of Aggradation)**
- **Increases Flood Capacity**

Design Solutions: Channel Processes

- Developed ***Eight Typical Design Scenarios***: Representative of the conditions present in watershed

Mechanical

Typical Design Scenarios				
Existing, Impaired Stream Type		Existing Condition	Proposed, Stable Stream Type	Valley Type (VT)
1.	D4	Poor	C4	VIII
2.	F4	Poor	B4c	II, III, VIIIa,b
3.	G4	Poor	B4	II, III, VIIIa,b
4.	C4	Poor	C4	VIIIa,b,c
5.	A4, Aa+, Fb F4 and G4	Poor	D4 / D4a	II, III, VIII
6.	F4b	Poor	B4	II, III, VIIIa,b
7.	A4 or A4a+	Poor	A4 or A4a+	II, III, VIIIa,b
8.	A4 or Aa+	Poor	B4a	II, IIIa,b, VIIIa,b

Design Scenario 7: *A poor* To A good

Design Scenario 7: *A poor* To A good

- **Reduces Bank Erosion 34 tons/yr per 1,000ft of channel**
- **Prevents Headcuts**
- **Dissipates Flow Energy**

Design Solutions: Channel Processes

- Developed ***Eight Typical Design Scenarios***: Representative of the conditions present in watershed

Mechanical

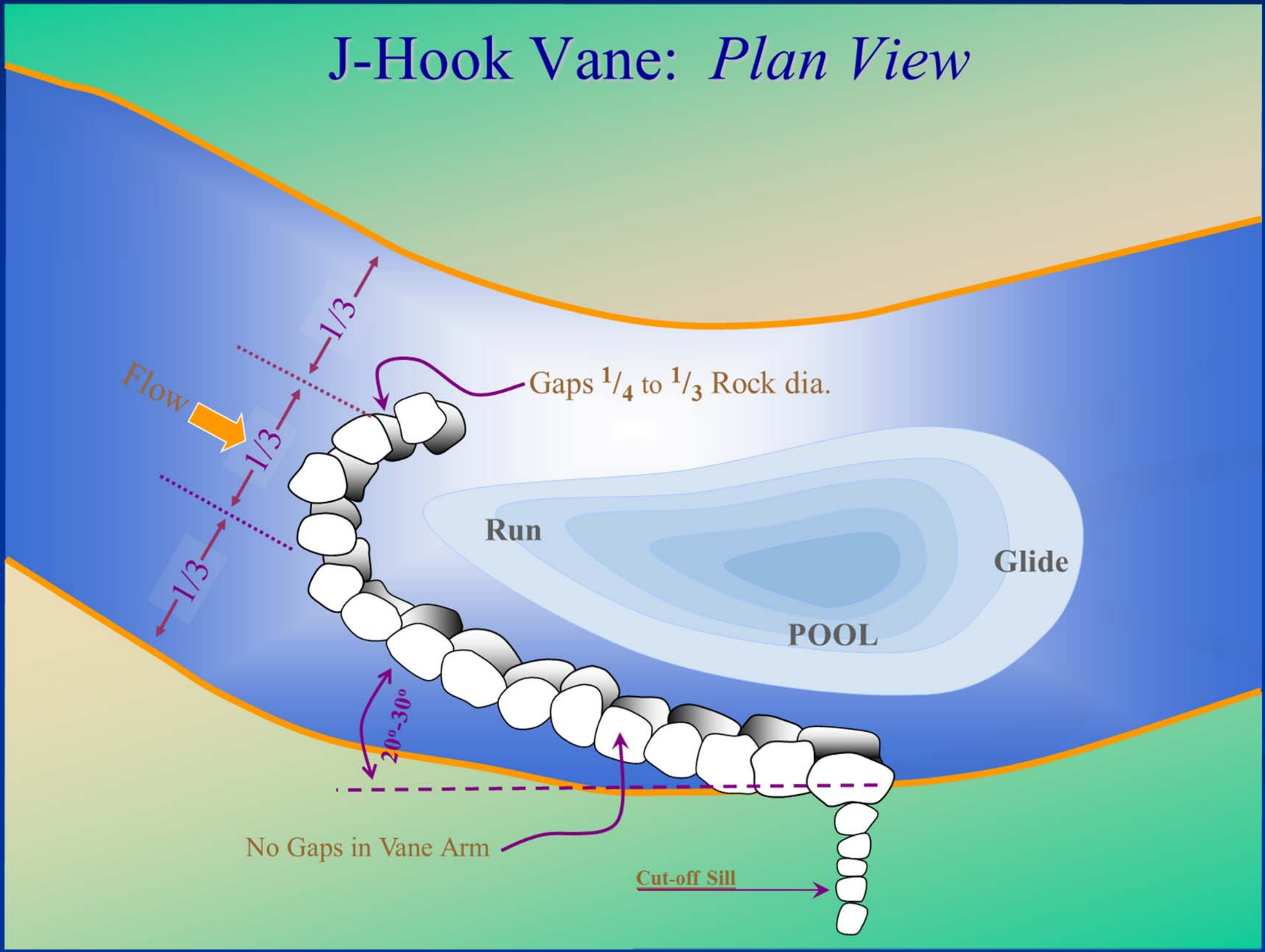
Typical Design Scenarios				
	Existing, Impaired Stream Type	**Existing Condition**	**Proposed, Stable Stream Type**	**Valley Type (VT)**
1.	D4	Poor	C4	VIII
2.	F4	Poor	B4c	II, III, VIIIa,b
3.	G4	Poor	B4	II, III, VIIIa,b
4.	C4	Poor	C4	VIIIa,b,c
5.	A4, Aa+, Fb F4 and G4	Poor	D4 / D4a	II, III, VIII
6.	F4b	Poor	B4	II, III, VIIIa,b
7.	A4 or A4a+	Poor	A4 or A4a+	II, III, VIIIa,b
8.	A4 or Aa+	Poor	B4a	II, IIIa,b, VIIIa,b

Design Scenario 8: *A* To Ba

Design Scenario 8: A4 to B4a

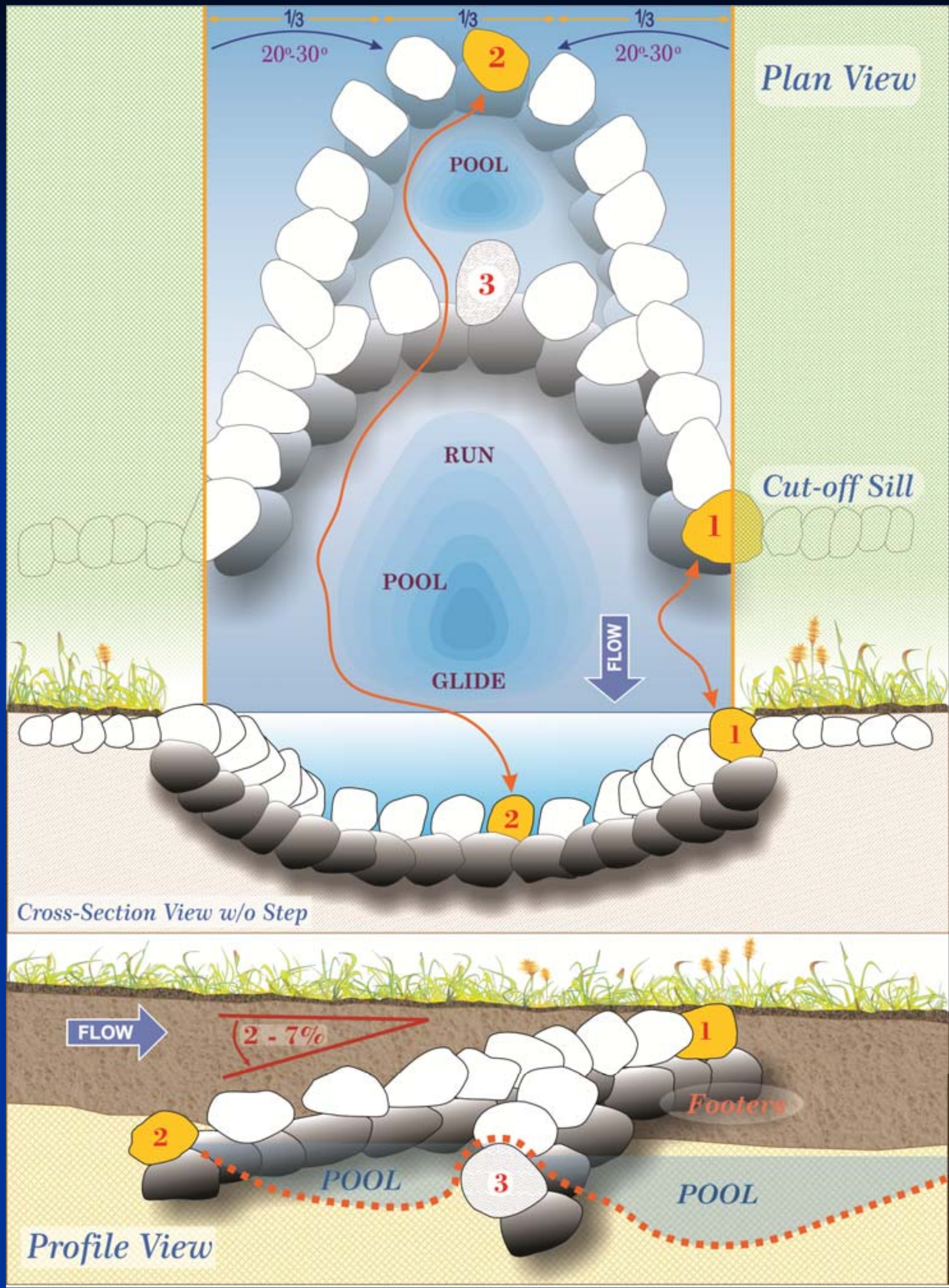
- Reduces Bank Erosion 34 tons/yr per 1,000ft of channel
- Prevents Headcuts
- Dissipates Flow Energy

Design Solutions : Structures



Design Solutions: Structures

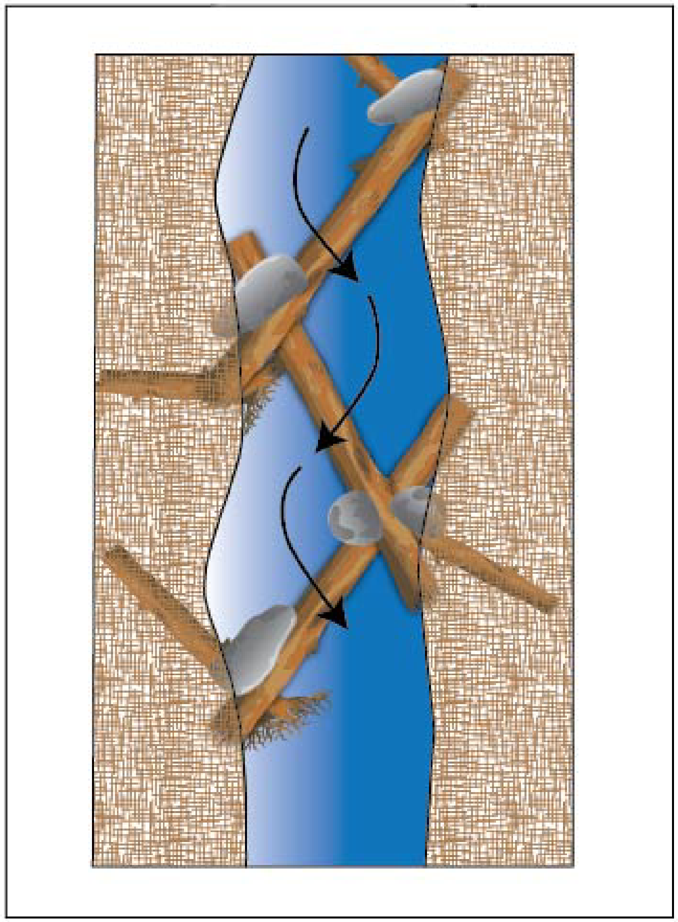
Design Solutions: Structures

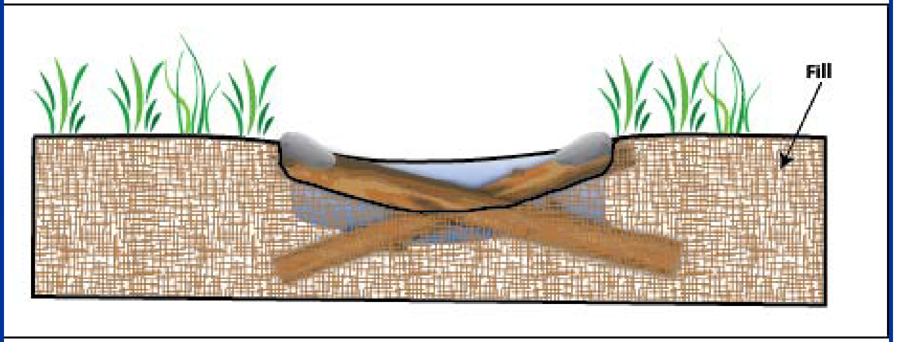


Design Solutions: Structures

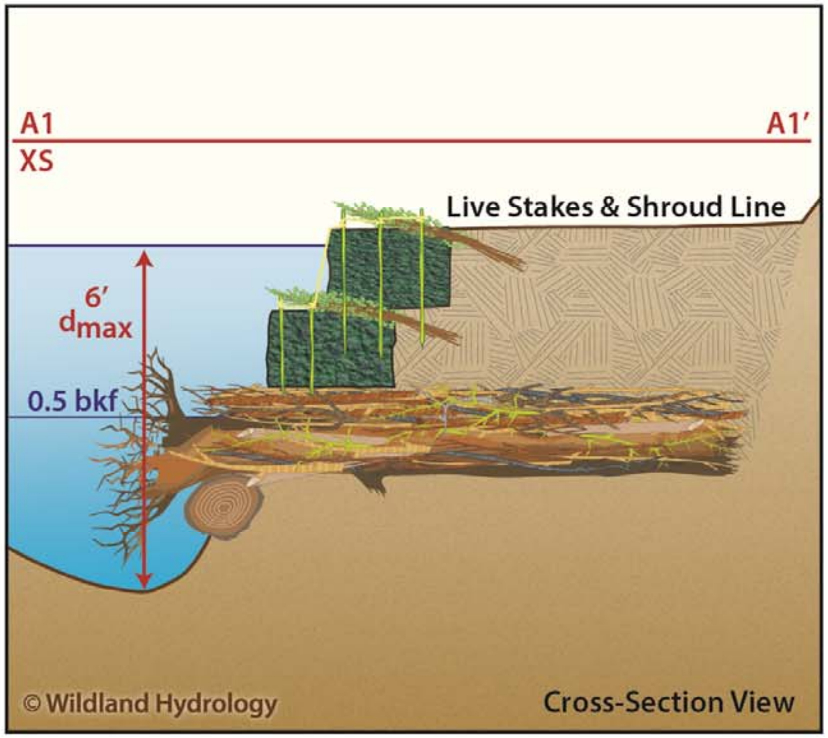
Design Solutions: Structures

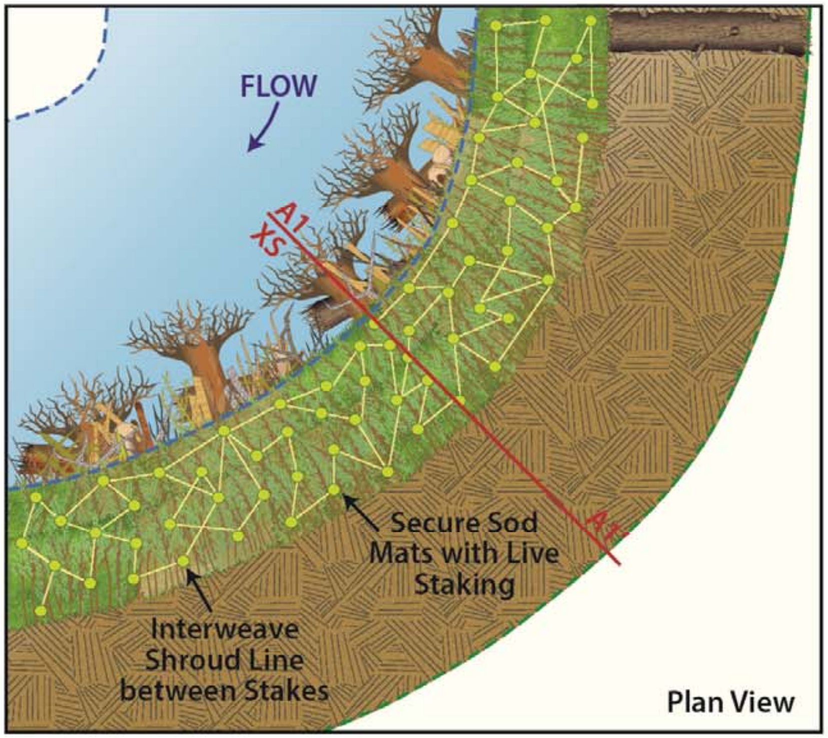
Log Rollers





Design Solutions: Structures





Design Solutions: Structures

Design Solutions: Channel Erosion – Mechanical

Structures	Bank Stabilization	Sediment Deposition	Flow Attenuation	Grade Control	Energy Distribution and Dissipation
J-Hook / Cross Vane	✓			✓	✓
Log / Rock Rollers	✓			✓	✓
Toe Wood	✓				✓
Debris Basin *		✓	✓	✓	✓
Cross-Channel Sills *				✓	✓
Converging Rock Clusters				✓	✓

* use only in ephemeral stream systems

Design Solutions: Channel Erosion – Mechanical

Structures	Scenario						
	D4 to C4	F4 to B4	G4 to B4	C4 to C4	F4, G4 or A4 to D4	F4b to B4	A4 to A4
J-Hook / Cross Vane	✓	✓	✓	✓		✓	✓
Log / Rock Rollers		✓	✓			✓	✓
Toe Wood	✓	✓	✓	✓		✓	
Debris Basin *					✓		
Cross-Channel Sills *					✓		
Converging Rock Clusters	✓	✓	✓	✓		✓	

* use only in ephemeral stream systems

Design Solutions: Channel Erosion – Hand Crews

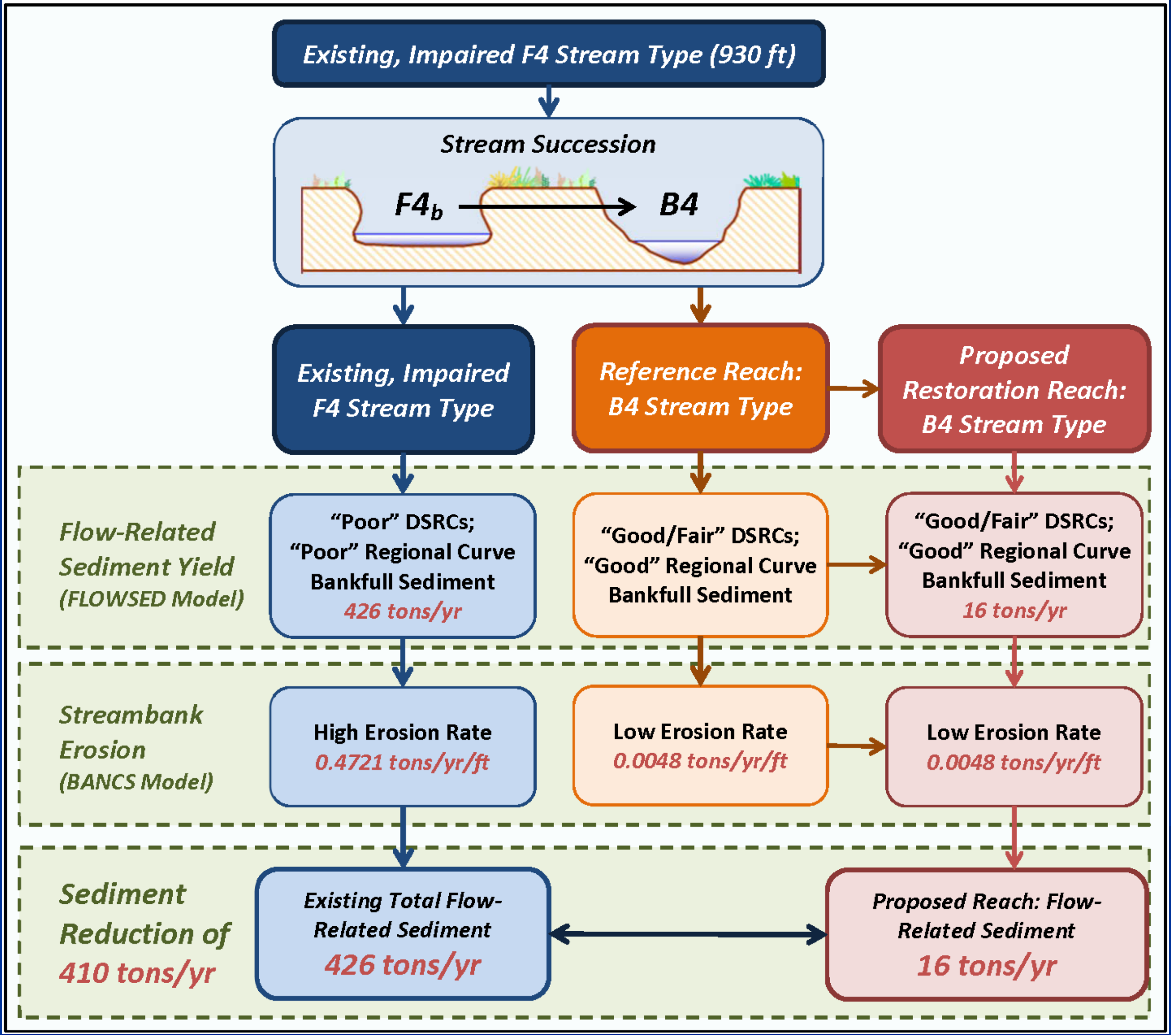
Structures	Bank Stabilization	Sediment Deposition	Flow Attenuation	Grade Control
Cross Channel Sills		✓	✓	✓
Gully Plug		✓	✓	✓
Log Rollers	✓			✓
Dissipators		✓	✓	✓

Conceptual Design Results

The following questions are addressed with this restoration master plan:

1. What are the post-fire impacts and potential adverse consequences?
2. What can be done to offset these impacts/consequences?
3. How effective would this be?
4. Where do we start?
5. How much will it cost?
6. When can we start?

3. How effective can the restoration work be?



The following questions are addressed with this restoration master plan:

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5. How much will it cost?
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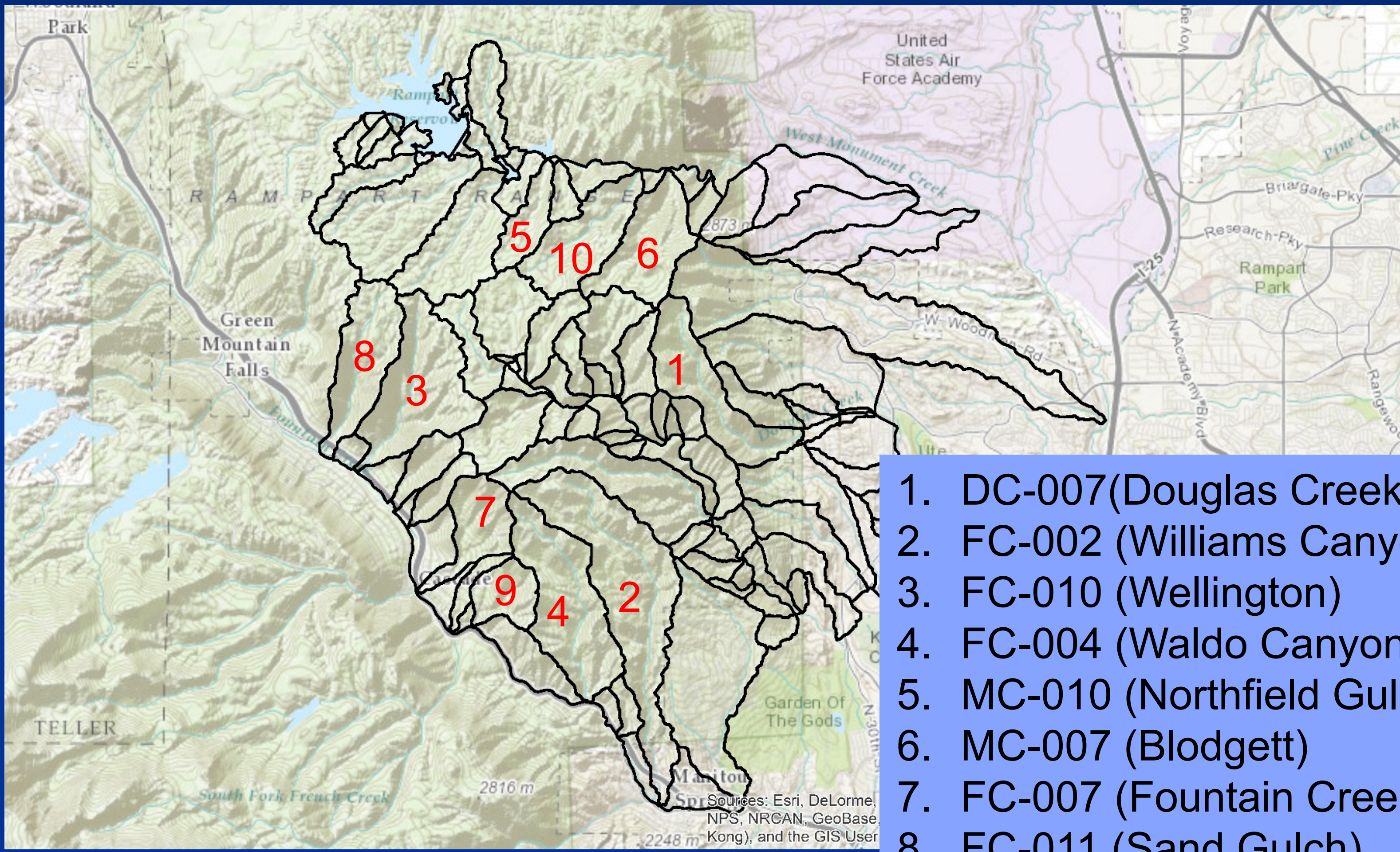
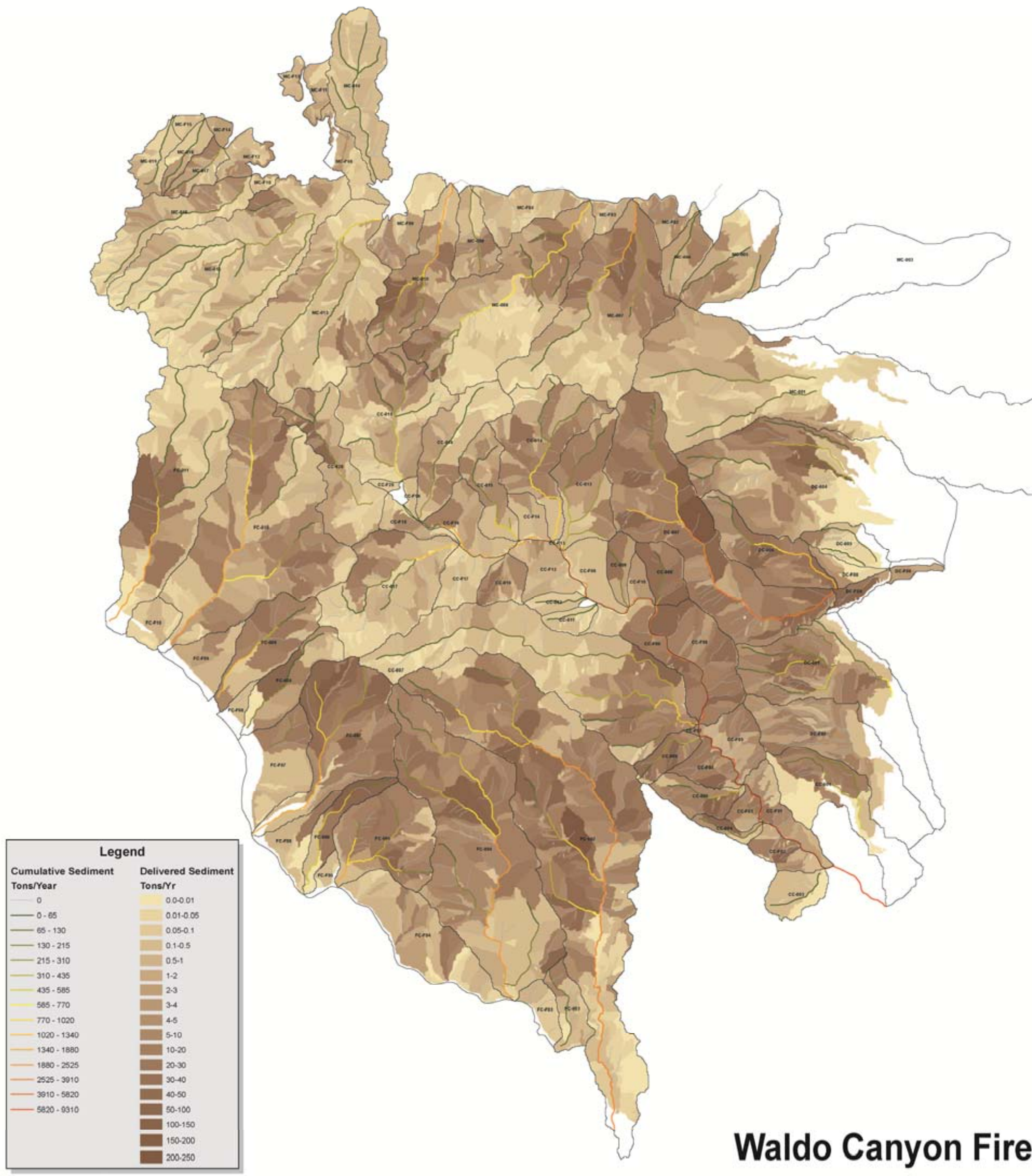
Top Sediment Producing Sub-Watersheds by Erosion Totals

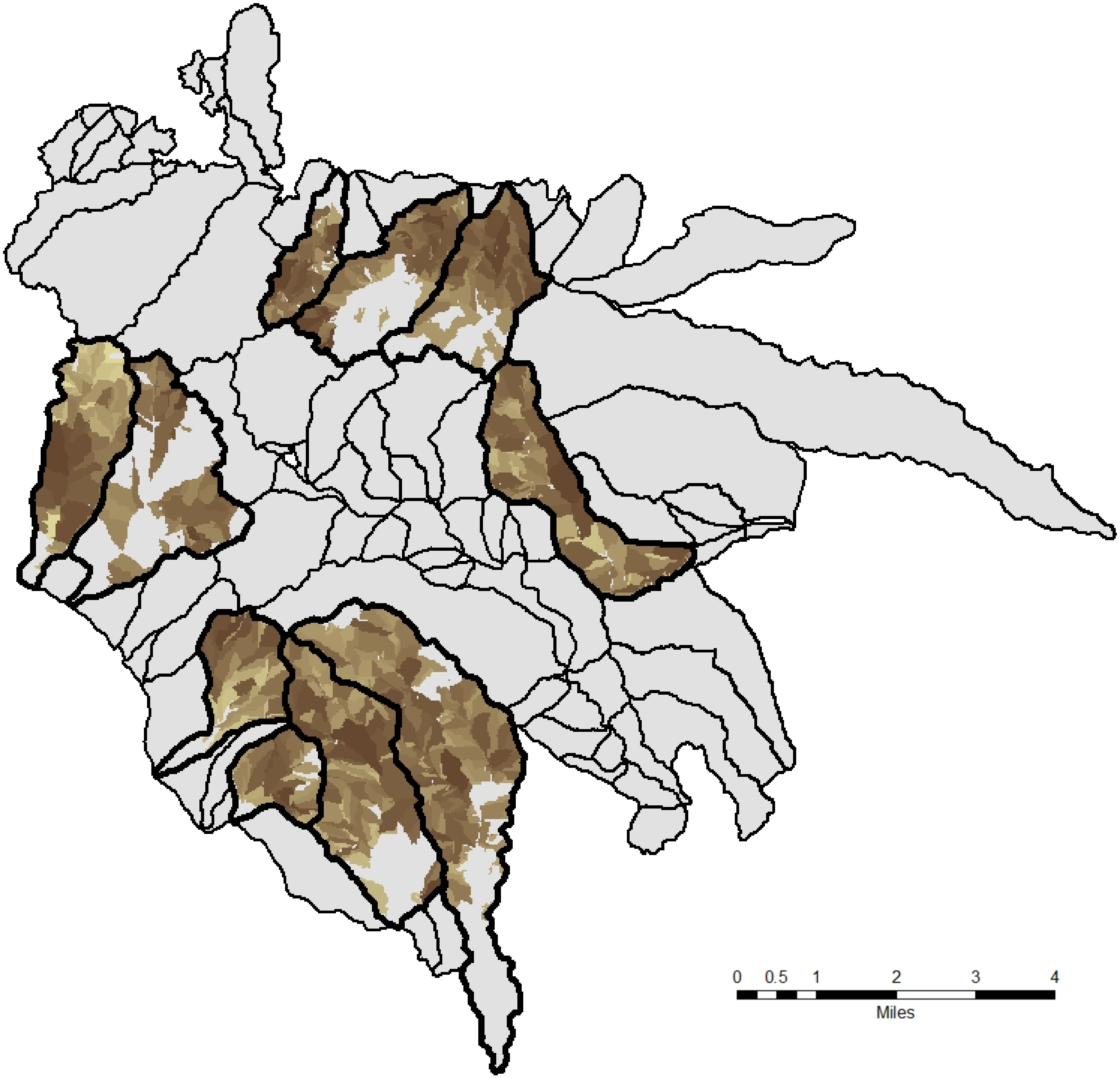


1. DC-007(Douglas Creek)
2. FC-002 (Williams Canyon)
3. FC-010 (Wellington)
4. FC-004 (Waldo Canyon)
5. MC-010 (Northfield Gulch)
6. MC-007 (Blodgett)
7. FC-007 (Fountain Creek Trib.)
8. FC-011 (Sand Gulch)
9. FC-005 (Fountain Creek Trib.)
10. MC-008 (Devils Kitchen)

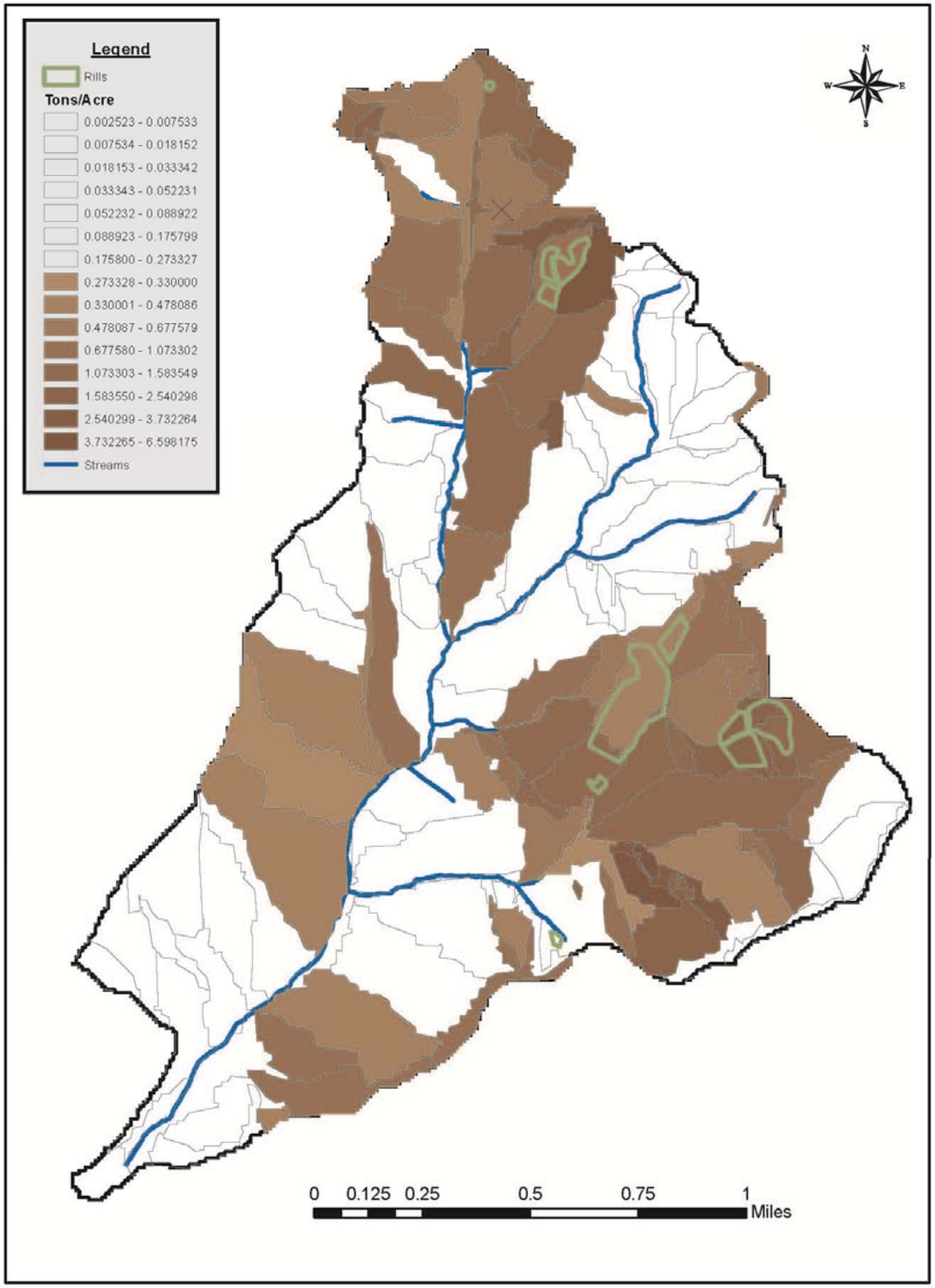
Sediment Summary

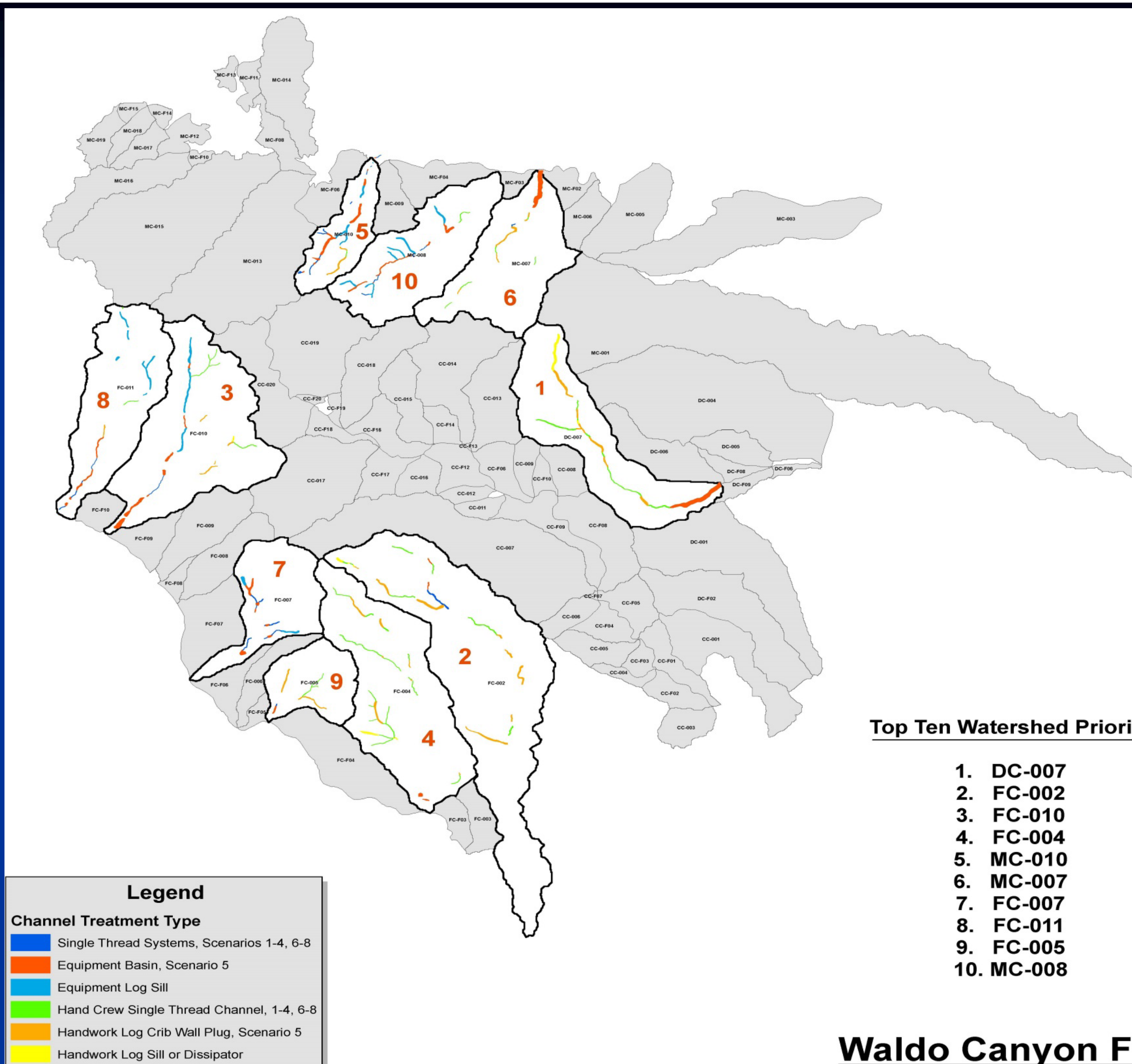
Top Sediment Producing Watersheds	Watershed	Average Annual Precip. (in)	Bankfull Discharge (CFS)	Water Yield Change (in)	Total Bank Erosion (tons/yr)	Sediment From Roads (Tons/yr)	Flow Related Sediment (Tons/yr)
1	DC-007	20.4	1.5	3.31	3673	6.7	53
2	FC-002	19.4	9.0	2.98	2388	13.7	1253
3	FC-010	21.9	6.7	3.38	2399	395	819
4	FC-004	20.1	6.8	4.04	1550	0.7	1056
5	MC-010	22.3	2.9	3.30	1548	296	168
6	FC-011	21.6	5.2	2.52	1467	0.0	370
7	MC-007	21.3	5.1	2.64	1426	0.0	378
8	MC-008	22.0	5.0	3.08	1157	17.0	422
9	CC-017	22.1	3.7	3.18	1192	0.0	255
10	FC-005	20.5	3.1	3.22	1246	0.6	182


Legend
Cumulative Sediment Tons/Year
0
0 - 65
65 - 130
130 - 215
215 - 310
310 - 435
435 - 585
585 - 770
770 - 1020
1020 - 1340
1340 - 1880
1880 - 2525
2525 - 3910
3910 - 5820
5820 - 9310
Delivered Sediment Tons/Yr
0.0-0.01
0.01-0.05
0.05-0.1
0.1-0.5
0.5-1
1-2
2-3
3-4
4-5
5-10
10-20
20-30
30-40
40-50
50-100
100-150
150-200
200-250
Waldo Canyon Fire


0 0.5 1 2 3 4
Miles

High Priority Treatment Areas to Reduce Sediment from Surface Erosion for Wellington Gulch



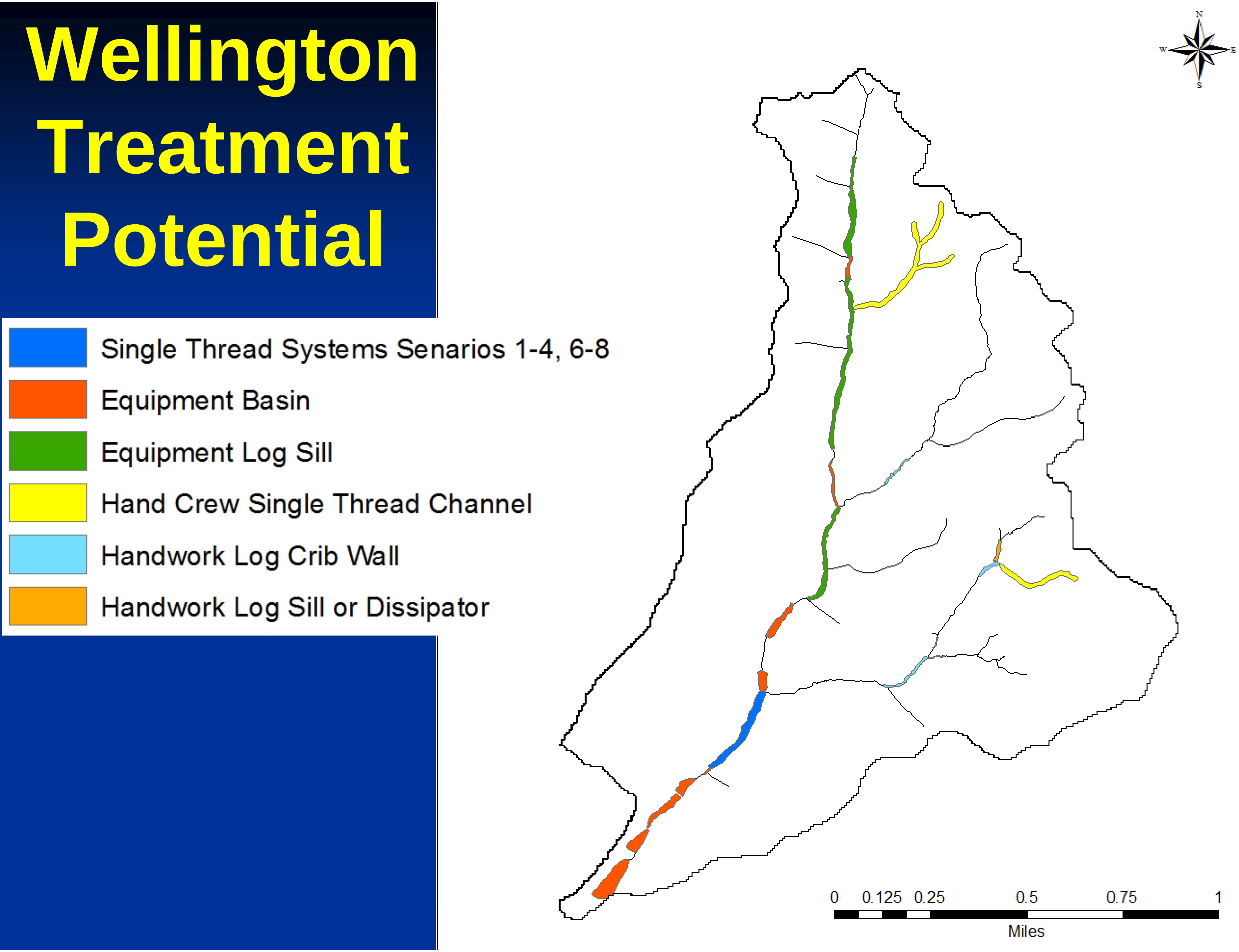


Top Ten Watershed Priority

1. DC-007
2. FC-002
3. FC-010
4. FC-004
5. MC-010
6. MC-007
7. FC-007
8. FC-011
9. FC-005
10. MC-008

Waldo Canyon Fire

Wellington Treatment Potential



Conceptual Design: Channel

Watershed	Channel Processes - Top Ten Sediment Producing Watersheds Watersheds				
	Total Length	Total Channel Treated	Total Channel Treated	Reduced Bank Erosion	Sediment Stored or Stabilized
	(ft)	(ft)	(%)	(tons/yr)	(tons)
DC-007	55,095	17,347	31%	2,417	30,370
FC-002	83,067	17,436	21%	9,942	23,160
FC-010	39,188	17,226	44%	1,968	27,624
FC-004	62,453	18,494	30%	1,388	11,054
MC-010	17,099	10,054	59%	1,284	44,133
MC-007	24,178	7,079	29%	1,447	13,380
FC-007	29,409	6,641	23%	1,033	16,429
FC-011	26,994	10,557	39%	1,123	20,196
FC-005	22,548	5,602	25%	783	9,267
MC-008	39,979	13,624	34%	366	30,051
Total	400,008	124,060	33%	21,751	225,664

Conceptual Design: Hillslope

Watershed	Hillslope Processes - Top Ten Sediment Producing Watersheds				
	Total Acres	Priority Area (acres)	Priority Area (%)	Delivered Sediment from Priority Area (%)	Delivered Sediment Reduction (%)
DC-007	823	430	52%	81%	61%
FC-002	1,684	865	51%	92%	69%
FC-010	1,100	528	48%	92%	69%
FC-004	1,124	568	50%	86%	65%
MC-010	308	171	55%	92%	69%
MC-007	729	384	52%	98%	74%
FC-007	475	228	48%	84%	63%
FC-011	718	464	64%	99%	74%
FC-005	336	191	56%	89%	67%
MC-008	710	382	53%	99%	74%
Total	8,006	4,211	53%	91%	69%

The following questions are addressed with this restoration master plan:

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2. What can be done to offset these impacts/consequences?
3. How effective would this be?
4. Where do we start?
5. How much will it cost?
6. When can we start?

Approximate Average Unit Costs

- Single-thread channel restoration:

  $ 25-$44/ lineal foot.
- Sediment detention basins:
  - $ 1.70-$10.00/ ton of sediment storage
- Aerial seeding/mulching: $ 2,500/acre
- Hand crew surface erosion treatments:

$ 1,000- 6,000/acre depending on level of difficulty, access, extent of work required.

The following questions are addressed with this restoration master plan:

1. What are the post-fire impacts and potential adverse consequences?
2. What can be done to offset these impacts/consequences?

   $ 2,500/acre
3. How effective would this be?
4. Where do we start?
5. How much will it cost?
6. When can we start?

We already started !

- Northfield Gulch sediment detention basins (Colorado Springs Utilities)
- North and South Douglas Creek sediment

detention basins, and priority 3 work (G4-B4 stream type). (On Flying W Ranch funded by NRCS with EQUIP. $ and Emergency Watershed Protection $ (EWP).

Summary

- This restoration will help reduce some of the flood risk for normal precipitation occurrences but will not significantly alter the impacts from potential catastrophic events as the hydrologic recovery will extend for many decades. Homes located on existing 100 year floodplains and alluvial fans will continue to be in harms way. Future development on floodprone areas should be discouraged as the potential flood risk will still be present.

Questions


PET WASTE
TRANSMITS DISEASE
LEASH AND CLEAN UP
AFTER YOUR PET
IT'S THE LAW!