Occurrence and Sources of E. coli in the Lower Rio Grande

Geoffrey B. Smith
Stephanie Turner and Wesley Hazen
New Mexico State University Biology Department

2010 – 2011 Lower Rio Grande Microbial Source Track Study

Four Source Tracking Sites:

2010: Anthony Bridge & E. Drain

2011: Leasburg Cable (N)
Sunland Park (S)

Basis for Bacterial Source Tracking Methods

E. coli is a natural inhabitant of warm-blooded animals such as humans, cattle, and birds.

Due to the unique biochemical environment in the gastro-intestinal tract of different animal hosts, the E. coli have become adapted to their animal “host” and many differ genetically from the E. coli in a different animal host.

Thus, it is possible to track the source of E. coli back to its animal host source using genetic analyses.

Brief Overview of Sampling Strategy.

At each site, samples were taken in triplicate or quadruplicate
and E. coli was enumerated using EPA-approved mColi-blue method.

When samples had greater than 200 E. coli / 100mL,
E. coli colonies were shipped to the IEH labs for source track analyses
(Pulsed-field gel electrophoresis , PFGE).

The sources of between 5 and 20 E. coli were identified in each sample.

Source track data is reported as the percent identified
for each source out of the total numbers of E. coli that were
source-tracked from each sample.

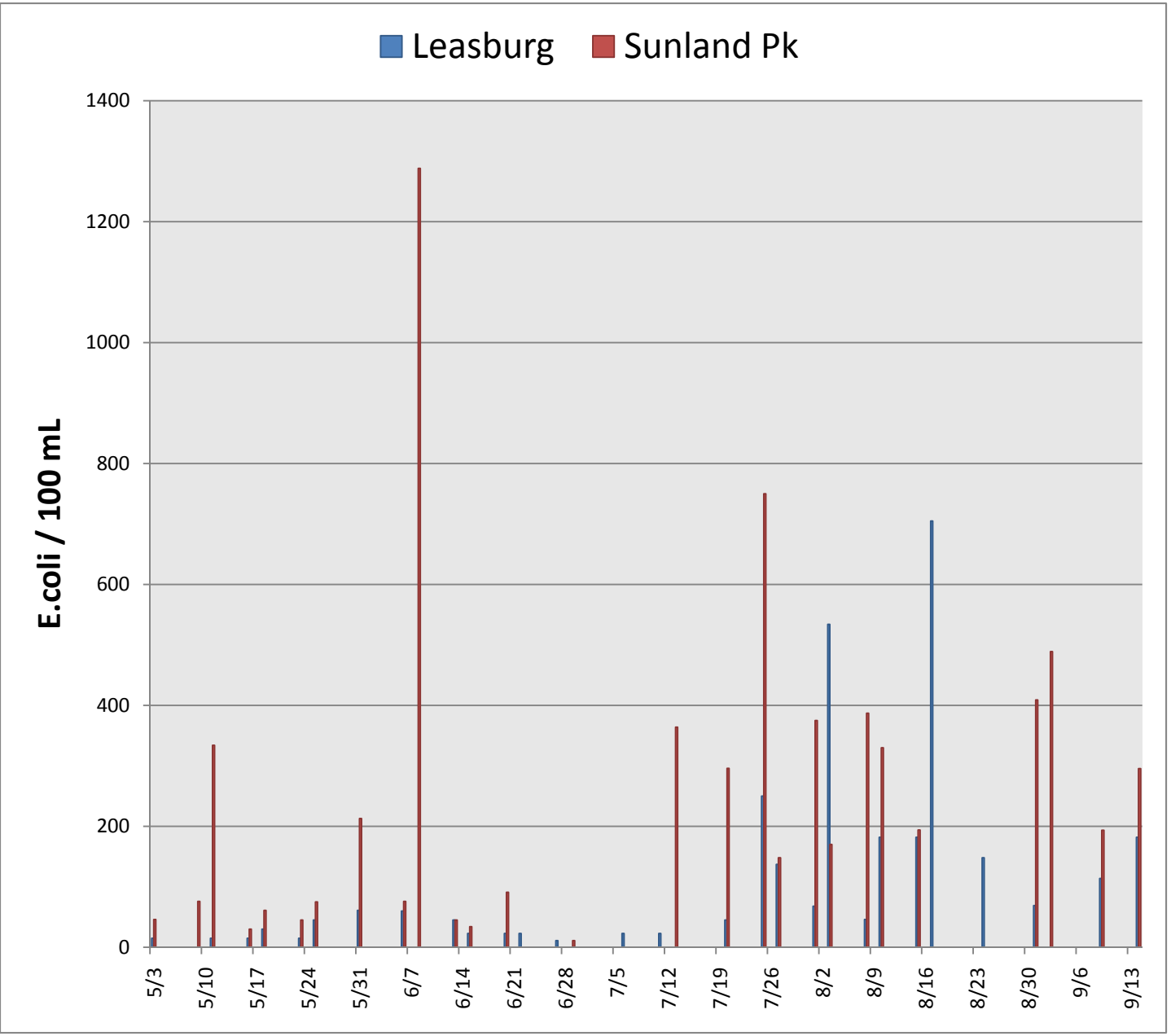
Outline of Results

I. E. coli Occurrence at Four Sites

II. Bacterial Load Calculations

III. Sources of E. coli

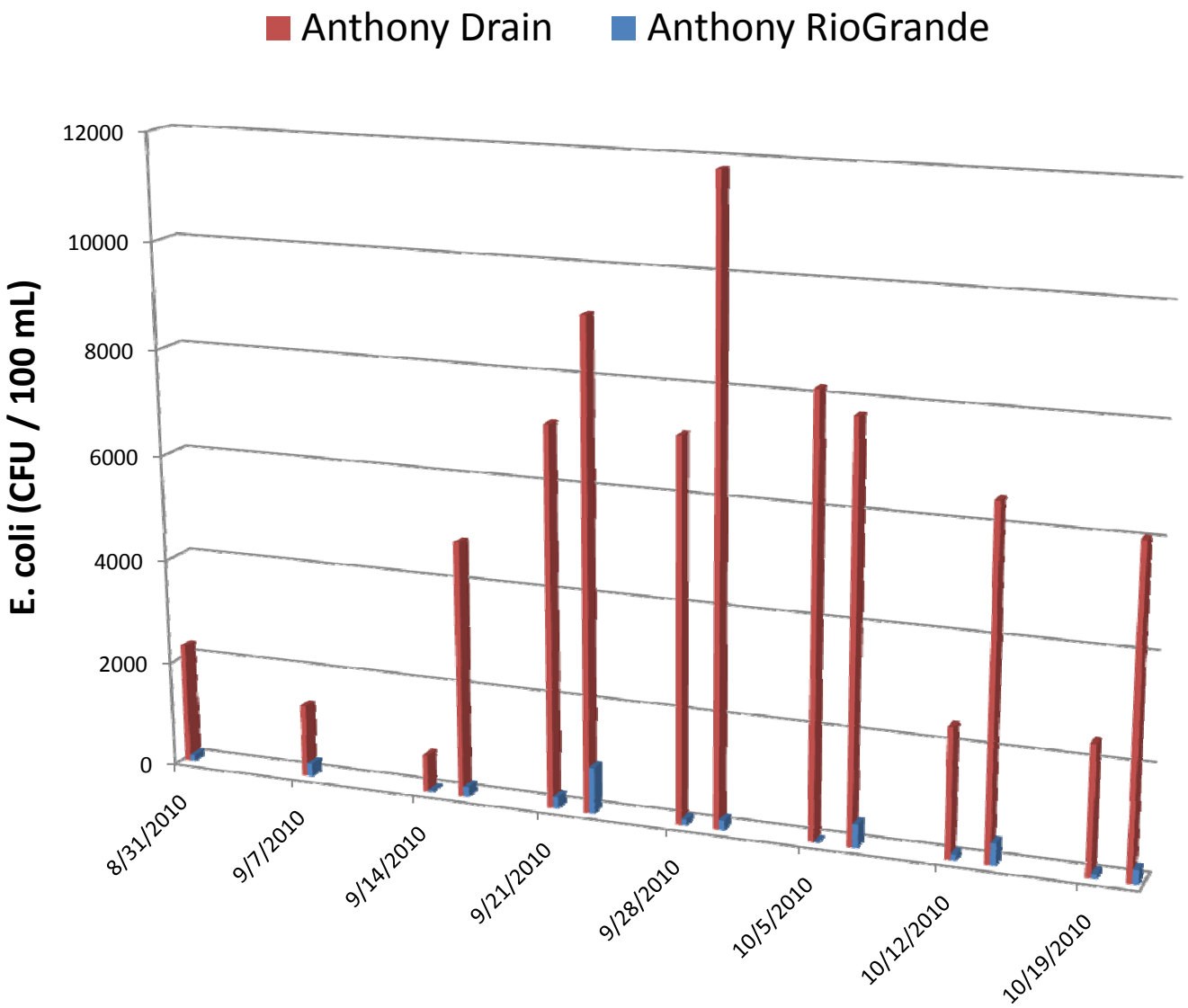
I. E. coli Occurrence. North and South Boundaries



Preliminary Report May 17, 2012

Besides peak in early June, levels were highest during July - August

I. Occurrence. Middle Section of Area. Anthony NM -- River and Drain



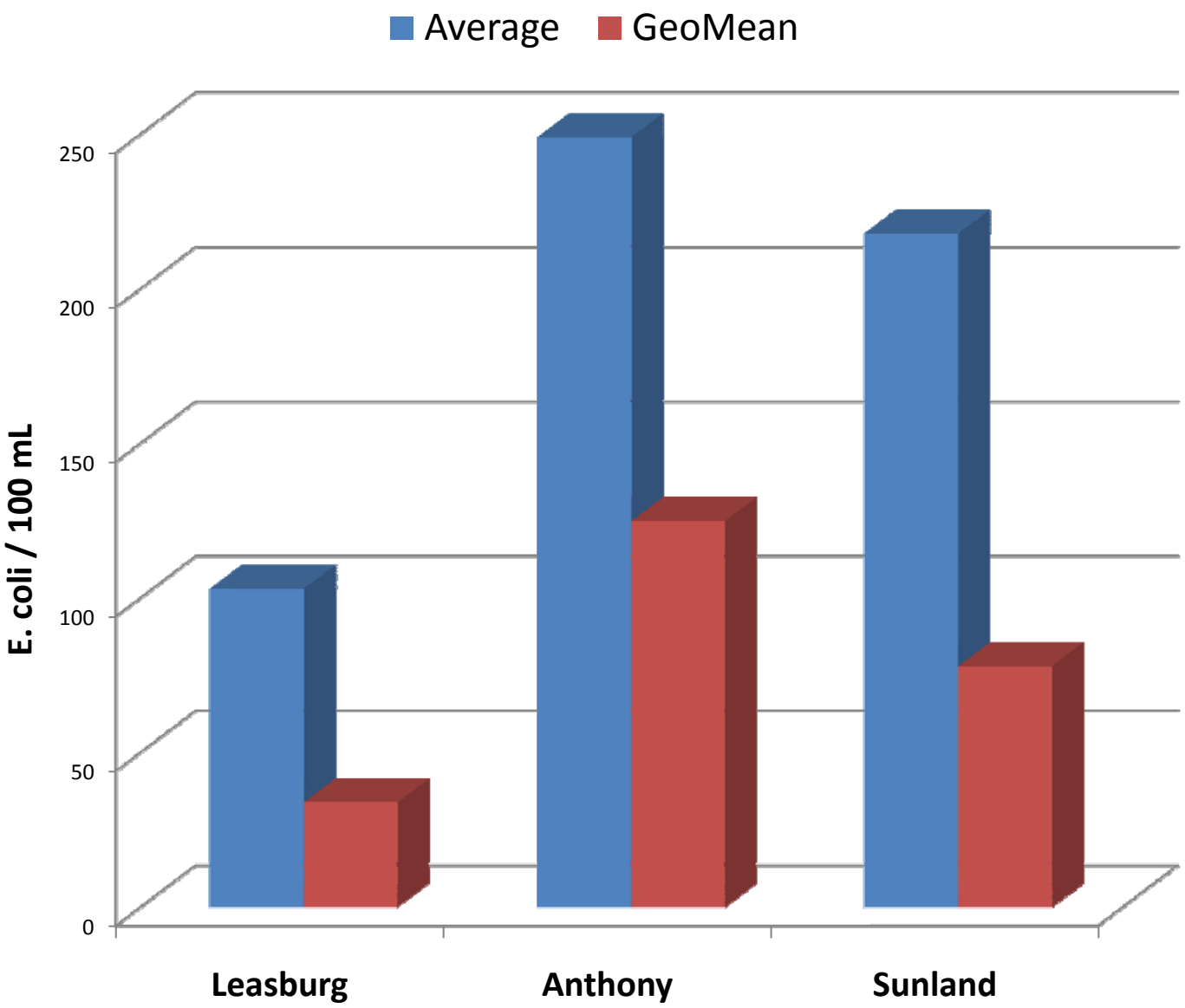
Concentrations in drain dwarf those in river

I. Middle Two of the Four Sampling Sites are in Exceedance for E. coli

Location	---------- # E. coli / 100 mL ---------- Avg (range)	Geometric Mean	Exceedance*
Leasburg River (n=117)	**103 (0 - 705)**	**34**	**No/No**
	249 (30 - 864)	***125.4***	
	5562 (697 - 11,833)	***4346***	
Sunland River (n=112)	**218 (0- 1288)**	**78**	**No/No**

***EPA limits for U.S. surface water recreational use: single sample: 235/100mL**
geometric mean: 126/100mL

I. Occurrence of E. coli at River Sites



River E. coli Exceedance only in Middle, at Anthony

II. Bacterial Load Estimates:

The basis for EPA's Total Maximum Daily Load (TMDL) Regulations

E. coli concentration x flow rate = total number of Ecoli in flow

		E. coli (CFU/100mL)	X	CFS (cu. ft. /sec)	=	"Bacterial Load" E. coli Flow Rate (CFU / sec)
6/30/2009	EastDrain	4000		25.2		2.85E+07
9/30/2009	EastDrain	20000		9.5		5.38E+07
8/24/2010	EastDrain	270		13.3		1.02E+06
9/30/2010	EastDrain	7500		9.2		1.95E+07
9/30/10	EastDrain	11833		9.2		3.08E+07
East Drain Avg.		**8721**		**13.3**		**3.26E+07***

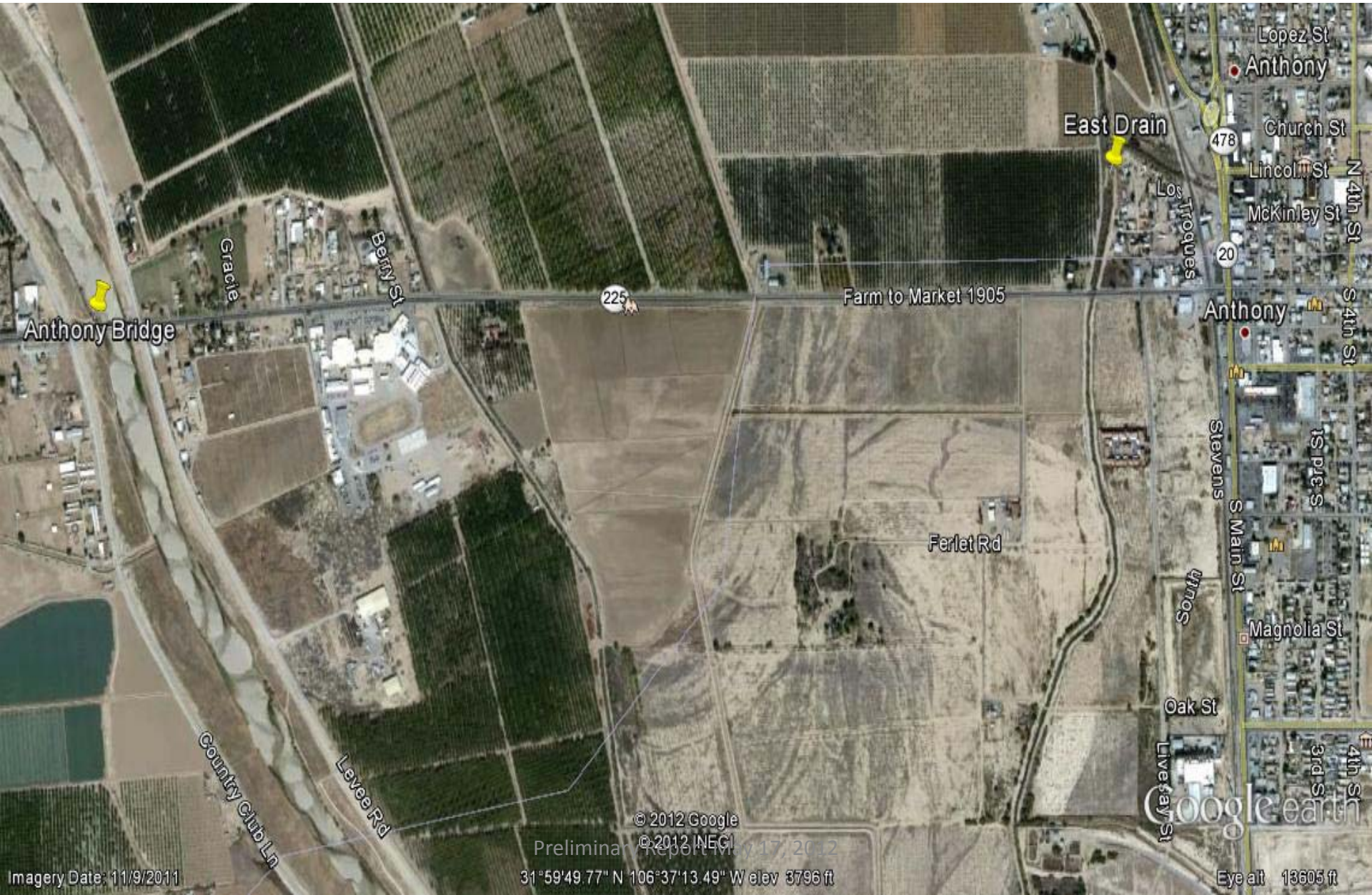
*At this avg. point in time, there are 32.6 million E. coli flowing past **per second** (in the cross section of water)

II. Bacterial Load Estimates:
How much E. coli is East Drain contributing to the river?

Date		E.coli CFU/100mL	cfs cu.ft/sec	"Load" CFU/sec
6/30/09	AnthonyRiver	510	805	1.16E+08
9/30/09	AnthonyRiver	400	243	2.75E+07
8/24/10	AnthonyRiver	81	988	2.27E+07
9/30/10	AnthonyRiver	200	260	1.47E+07
9/30/10	AnthonyRiver*	182	260	1.34E+07
	An. River Avg	**275**	**511**	**3.98E+07**
East Drain Avg.		**8721**	**13.3**	**3.26E+07***

40 million in the river and the drain adds 33 million.
One drain almost doubles what's in the river!

East Drain, adjoining town of Anthony, is 1.6 mile East of Anthony river and drains into river 2.3 miles to the south



Where Mesquite Drain dumps into East Drain
6 miles north of East Drain sampling site

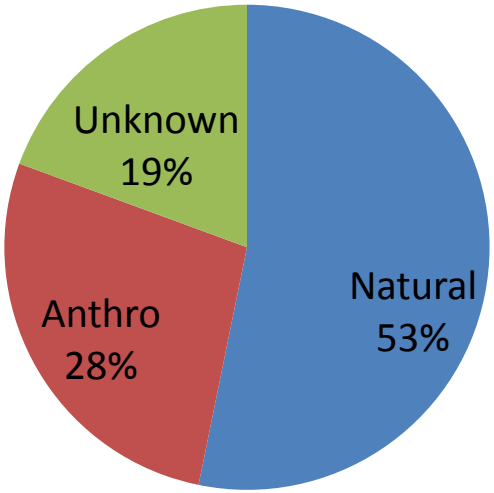
E. Coli Levels
2727 / 100 mL at 9:03 AM 8/31/10

Would the E. coli die after traveling
2.6 miles to the river?
Future Study

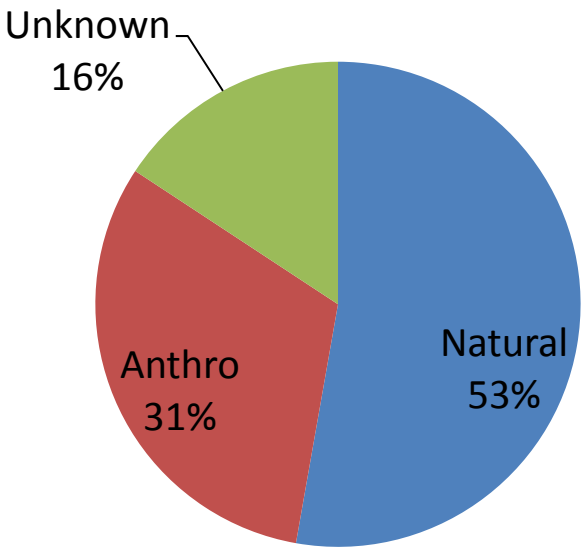
2273 / 100 mL at 8:35 AM 8/31/10
East Drain

III. Overview of Sources of E. coli.

RioGrande @ Leasburg



RioGrande @ Sunland



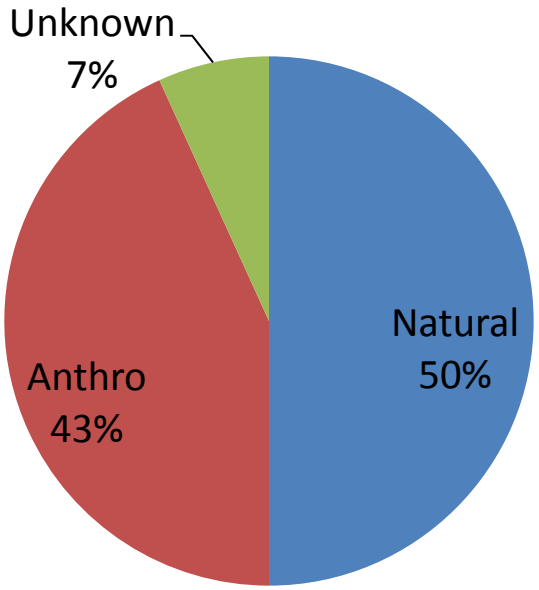
Leasburg n = 62; Sunland n = 127

Anthropogenic = Sewage
Bovine
Horse
Dog
Feline
Porcine
Goat
Sheep

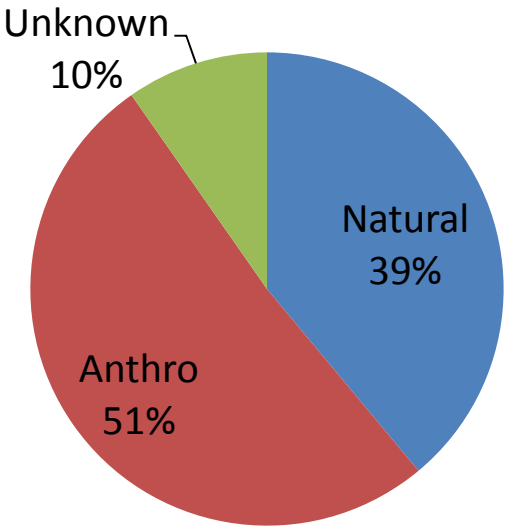
Natural = Duck
Goose
Avian (duck/goose, but also includes chicken)
Raccoon
Beaver
Canine
Deer

III. Overview of Sources of E. coli.

Rio Grande @ Anthony



East Drain @ Anthony



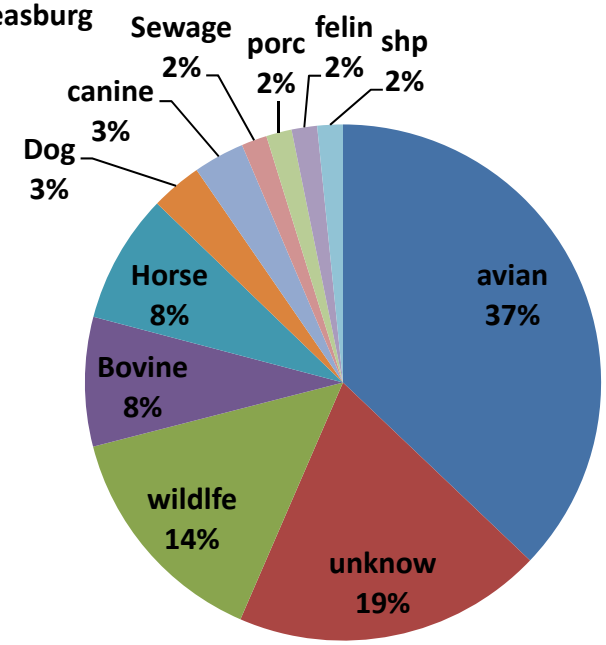
Rio Grande n = 74; East Drain n = 113

Anthropogenic = Sewage
- Bovine
- Horse
- Dog
- Feline
- Porcine
- Goat
- Sheep

Natural =
- Duck
- Goose
- Avian (duck/goose, but also includes chicken)
- Raccoon
- Beaver
- Canine
- Deer

III. Specific Sources – North and South Boundaries

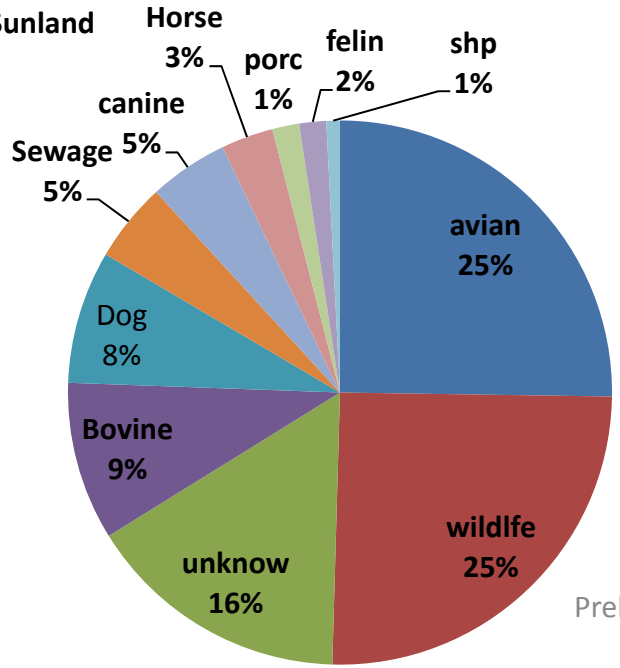
RioGrande.Leasburg



Leasburg, n = 62

	% of Total
avian	37.1
unknown	19.4
wildlife	14.5
Bovine	8.1
Horse	8.1
Dog	3.2
canine	3.2
Sewage	1.6
Porcine	1.6
Feline	1.6
Sheep	1.6

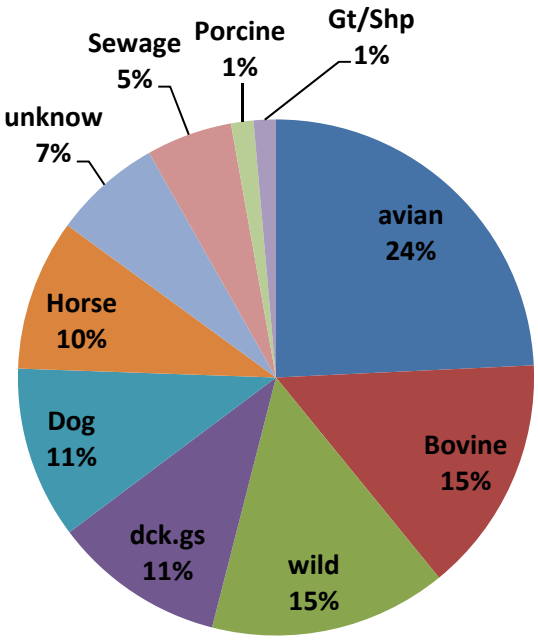
RioGrande.Sunland



Sunland, n = 127

	% of Total
avian	25.2
wildlfe	25.2
unknown	15.7
Bovine	9.4
Dog	7.9
Sewage	4.7
canine	4.7
Horse	3.1
Porcine	1.6
Feline	1.6
Sheep	0.8

RioGrande.Anthony

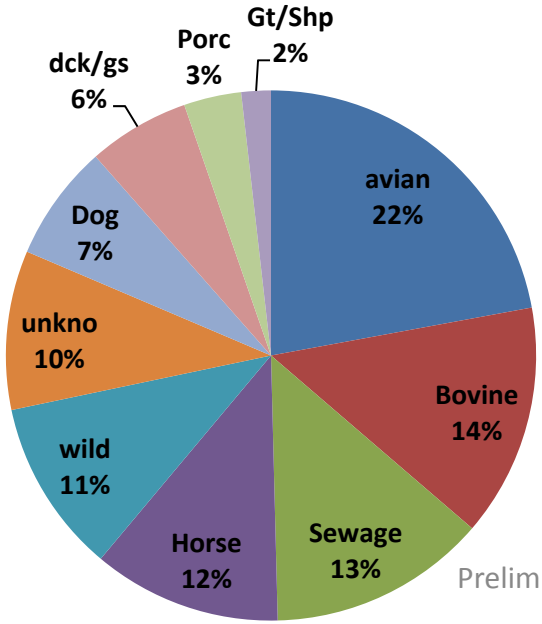


III. Specific Sources – Central River vs. Drain

Anthony, n= 74

	% of Total
avian	24.3
Bovine	14.9
wild	14.9
duck.geese	10.8
Dog	10.8
Horse	9.5
unknown	6.8
Sewage	5.4
Porcine	1.4
Goat.Sheep	1.4

EastDrain

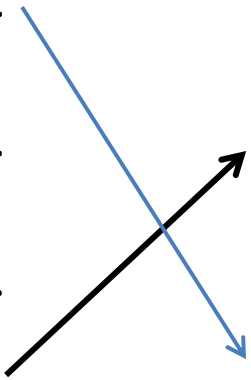


East Drain, n = 113

	% of Total
avian	22.1
Bovine	14.2
Sewage	13.3
Horse	11.5
Wild	10.6
unknown	9.7
Dog	7.1
duck.geese	6.2
Porcine	3.5
Goat.Sheep	1.8

III. Specific Sources – North and South Boundaries

Leasburg	% of Total	Sunland	% Total
avian	37.1	avian	25.2
wildlfe	14.5	wildlfe	25.2
Bovine	8.1	Bovine	9.4
Horse	8.1	Dog	7.9
Dog	3.2	Sewage	4.7
canine	3.2	canine	4.7
Sewage	1.6	Horse	3.1



Sunland Park Race Track ~ taking care of its manure

III. Specific Sources - Central River vs. Drain

Rio Grande @ Anthony		East Drain	
--------- Percent of Total Sources ----------			
avian	35.1	avian	28.3
Bovine	14.9	Bovine	14.2
wild	14.9	Sewage	13.3
Dog	10.8	Horse	11.5
Horse	9.5	wild	10.6
Sewage	5.4	Dog	7.1

2.5 fold more sewage in drain than in river

Interpretation: water leaving the reach is not as good as what entered, but, compared to Anthony, apparently has improved as it leaves NM.

	Mean Number of E. coli	Source of E. coli: Sewage	Bovine	total human impact
Leasburg[2]	34	1.6%	8.1%	28%
Anthony[1]	125	5.4%	14.9%	43%
E.Drain[1]	4346	13.3%*	14.2%	51%
Sunland[2]	78	4.7%	9.4%	31%

If East drain maintains bacterial load 2.6 mi south at Rio Grande, it is dumping 4.3 million E. coli from human sewage* per second into river.

Note problems w/ comparisons: a. different seasons (2010[1], 2011[2])
b. river vs drain (East Drain had more than 50 times higher levels of E. coli than avg. river)

III. Overall Average Source Attribution from the Four Project Sites

Bird:	31%	
Livestock:	23%	(12% Bovine, 8% Horse)
Wildlife:	18%	
Unknown:	13%	
Pets:	8%	(7.2% Dog)
Sewage:	6%	

Conclusions

I. E.coli Occurrence. A. In both 2010 and 2011, maximal levels of E. coli peaked during late summer monsoon season.

B. Levels were very high in East Drain

C. Anthony levels were high compared to water above and below stream

II. E. coli Load Analysis of one drain shows it is probably contributing significant quantities of E. coli to the river.
A study is needed to compare E. coli in canals (from river to fields) vs. E.coli in drains (from fields back to river). And E. coli inactivation rates need to be documented and compared between river and drains

III. As in other New Mexico source tracking studies,
birds were the main contributor (31% of total).
Livestock contribution(23%) was largely Bovine (12%) and Horse (8%)

Acknowledgements

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