Update of Lost Soldier/Wertz Floods

Living in a Constrained CO_2 Environment

Karan E. Eves
Juan J. Nevarez

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Midland, Texas

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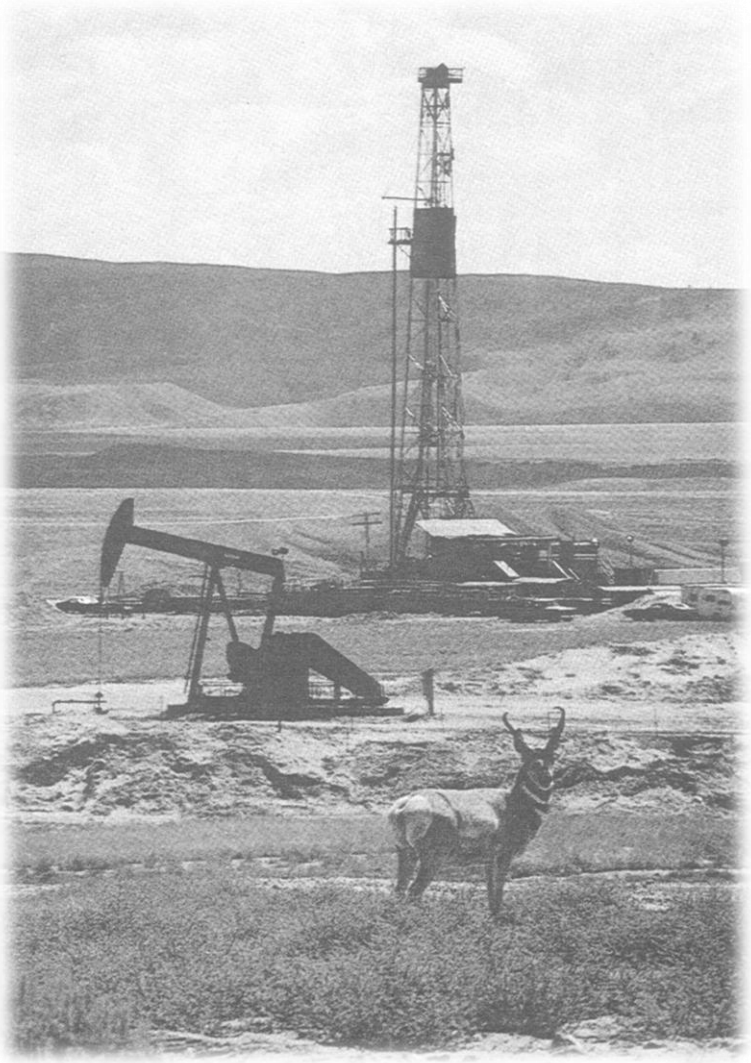
Agenda

- Field Background
  - Location
  - Geological Information
  - Field Development
  - Field Process Overview
- Field Performance
  - Reservoir Properties
  - Historical Production
- CO_2 Constraints
  - CO_2 Historical Purchases
  - CO_2 Allocation Process
  - New WAG Management Tools
  - Case Studies
    - Wertz Tensleep
    - Lost Soldier Cambrian
- Future Challenges



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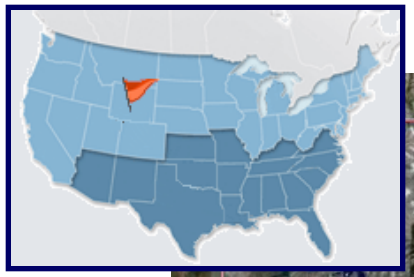
Location



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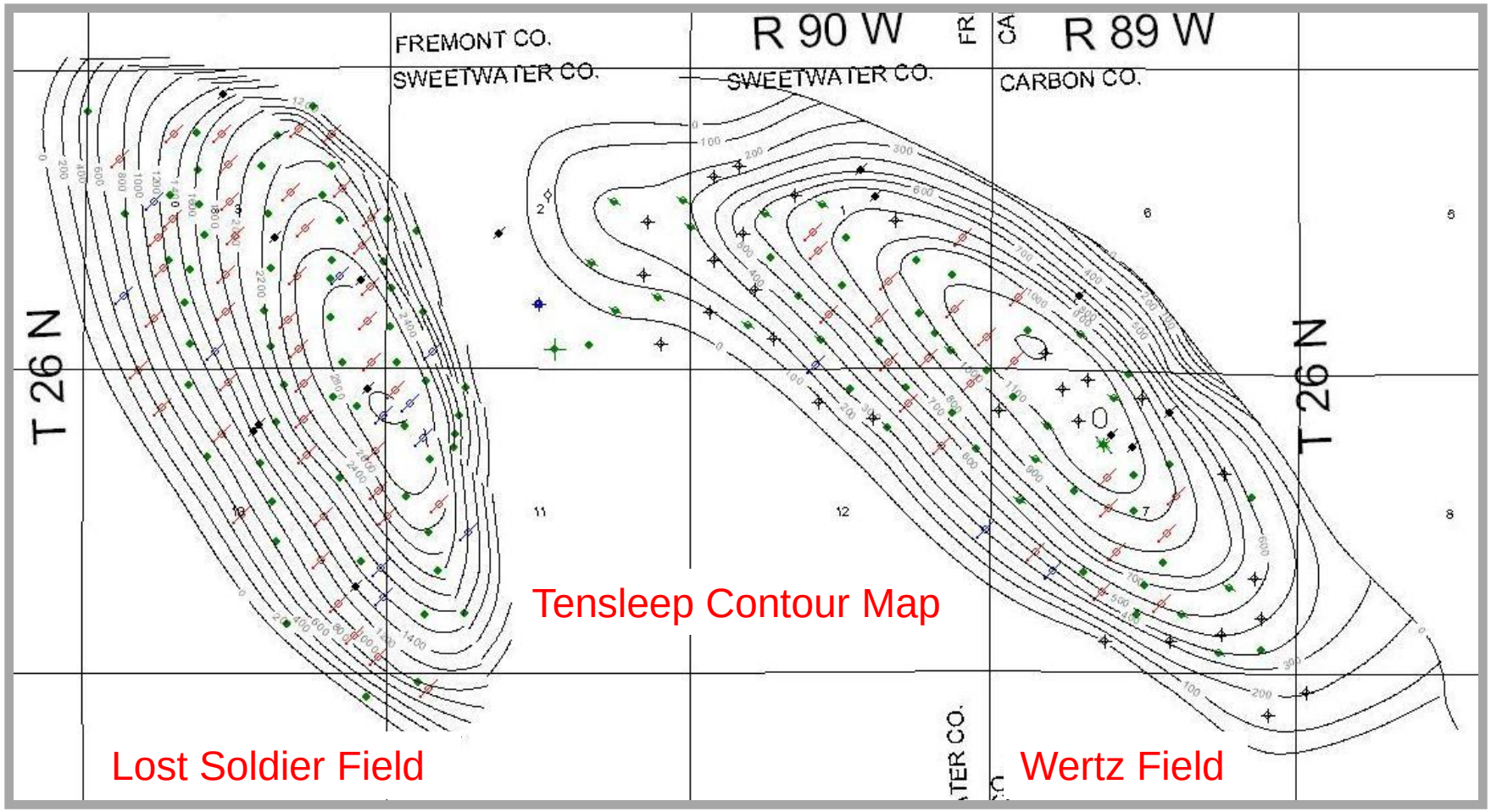
Geological Information



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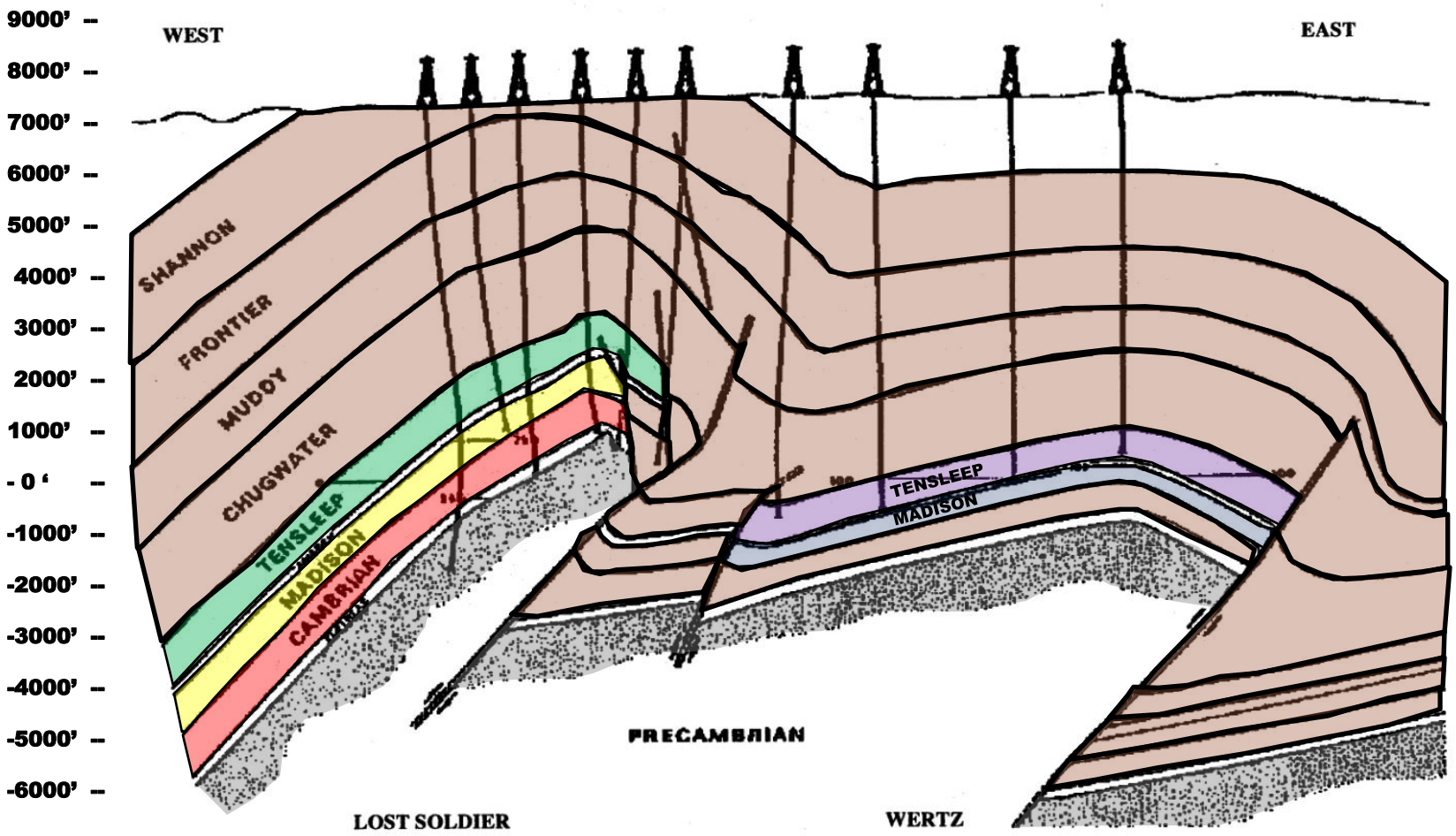
Geological Information



- Lost Soldier and Wertz are both faulted anticlines.
- Located in Wyoming's Great Divide Basin

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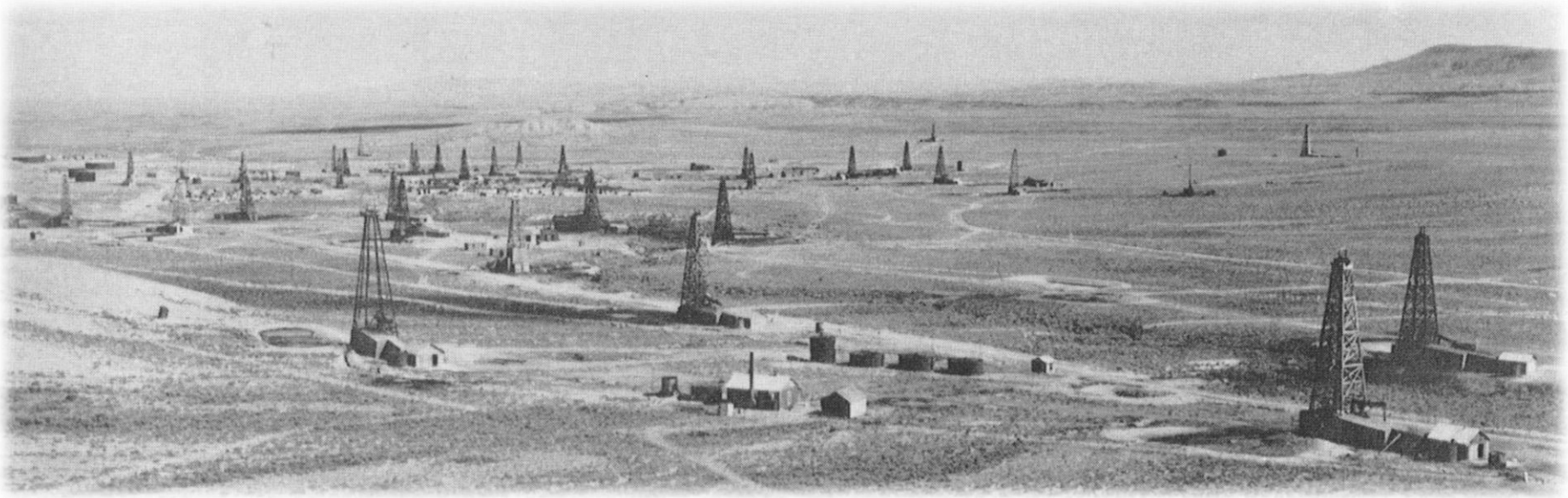
Field Statistics

- Field Size : 5,500 Acres
- Productive Acres: 4300
- Reservoir Depth: 4500-7500 ft
- Pay Thickness: +/- 1000 ft
- OOIP: 660 MMBO
- Cum Recovery: 342 MMBO



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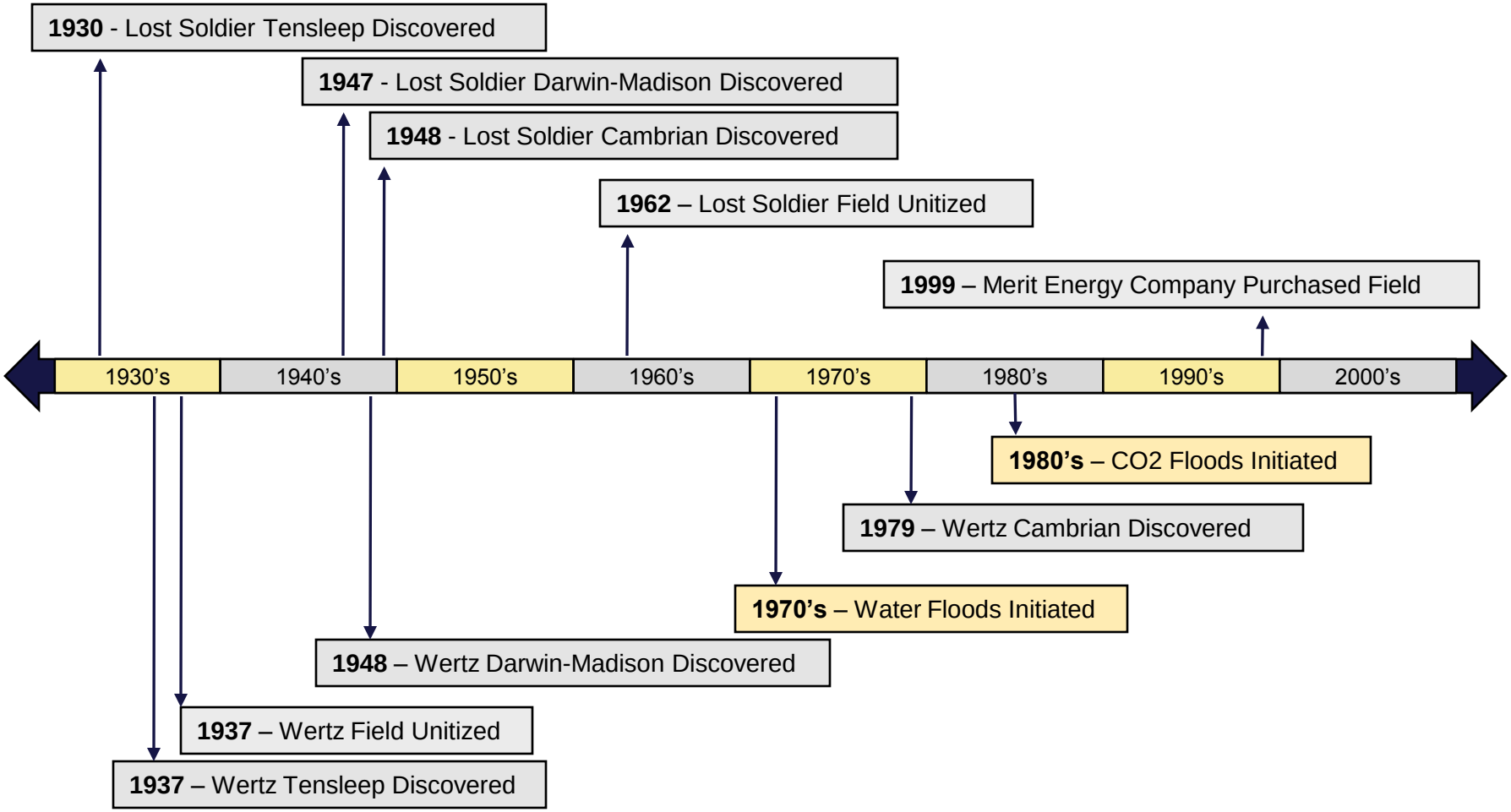
Field Development



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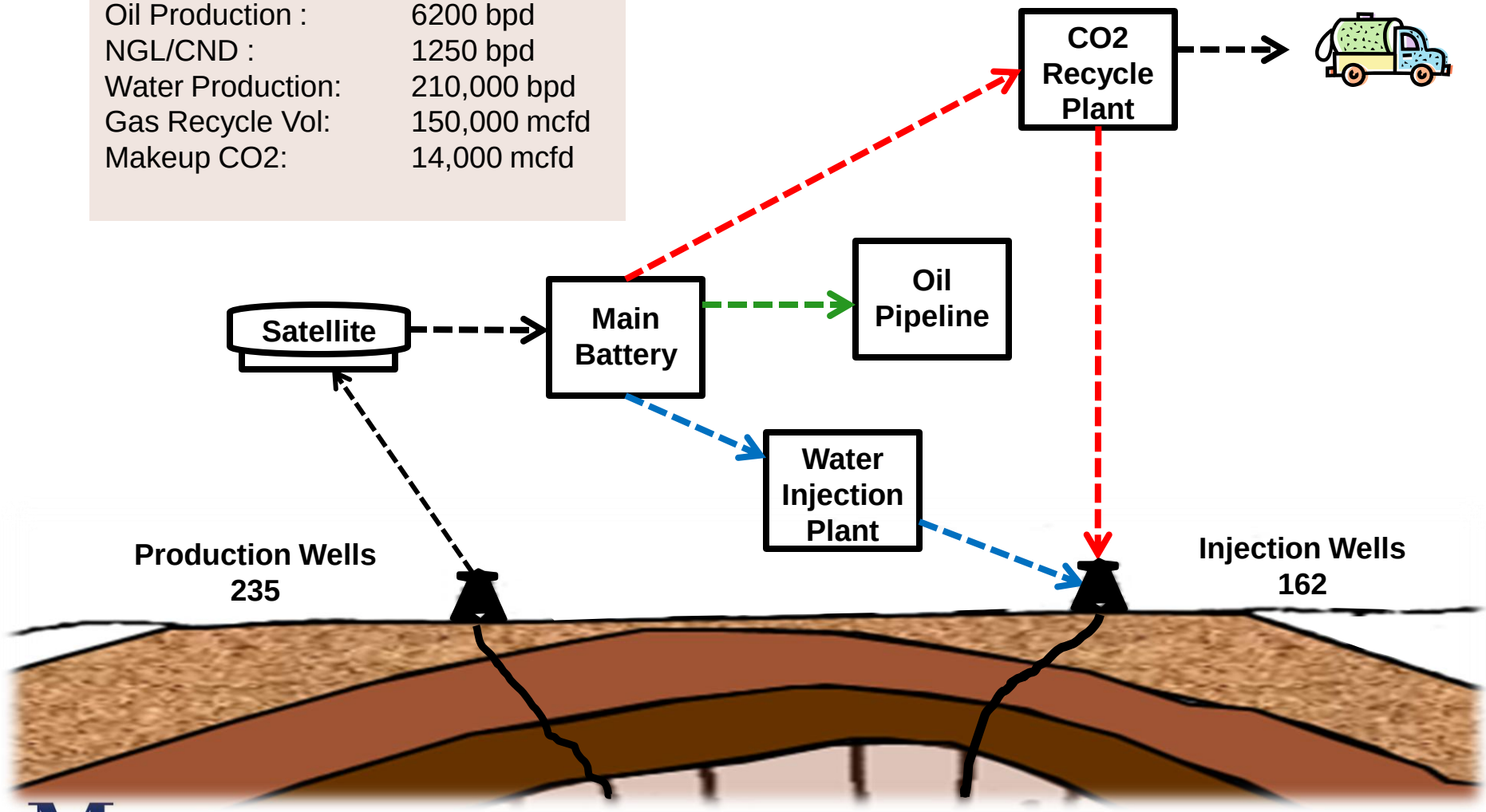
Field Process Overview

Field Statistics

Oil Production :	6200 bpd
NGL/CND :	1250 bpd
Water Production:	210,000 bpd
Gas Recycle Vol:	150,000 mcfd
Makeup CO2:	14,000 mcfd



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Reservoir Background

Critical Reservoir Properties for the three main producing formations:

Field	Formation	Lithology	Average Depth	Formation Thickness	Average Porosity	Air Perm md	Current Spacing	Res Press psi
Lost Soldier	Tensleep	SS	5,000	535	9.9%	31.0	10 - 20	2,800
	Darwin	SS	5,500	65	13.0%	36.0	20 -30	2,650
	Madison	LS/DOL	5,565	340	9.0%	2.5	20 -30	2,650
	Cambrian	SS	7,000	200	10.5%	30.0	30 - 40	3,700
Wertz	Tensleep	SS	6,200	425	10.9%	20.0	10 - 20	3,500
	Darwin	SS	6,625	75	13.1%	36.0	20 -30	3,300
	Madison	LS/DOL	6,700	400	8.7%	2.5	20 -30	3,300

- Primary production was attributed to fluid expansion, water influx and gravity drainage
- All of the formations above are currently CO_2 flooded
- Miscibility Pressure 2,350 psi

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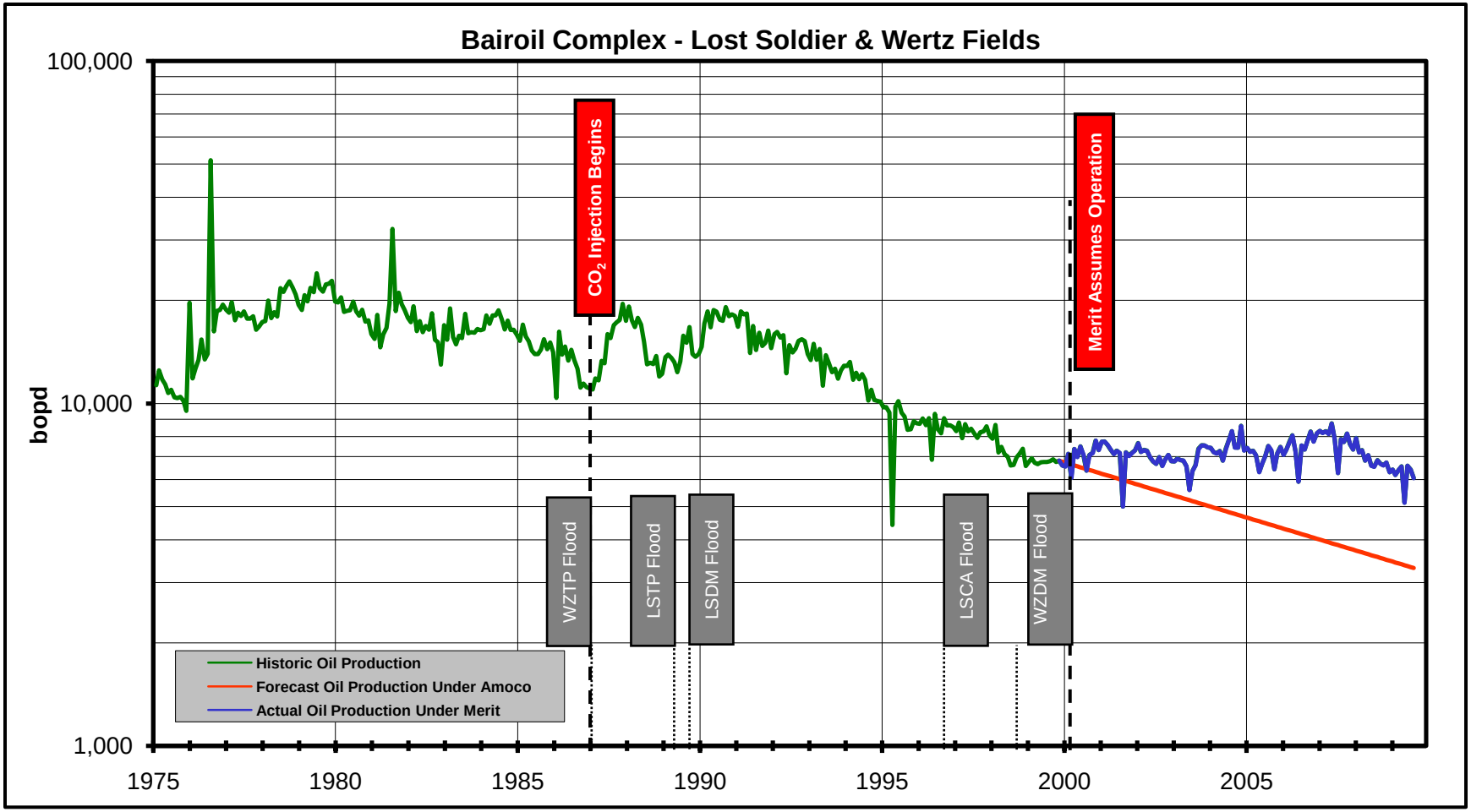
Historical Production



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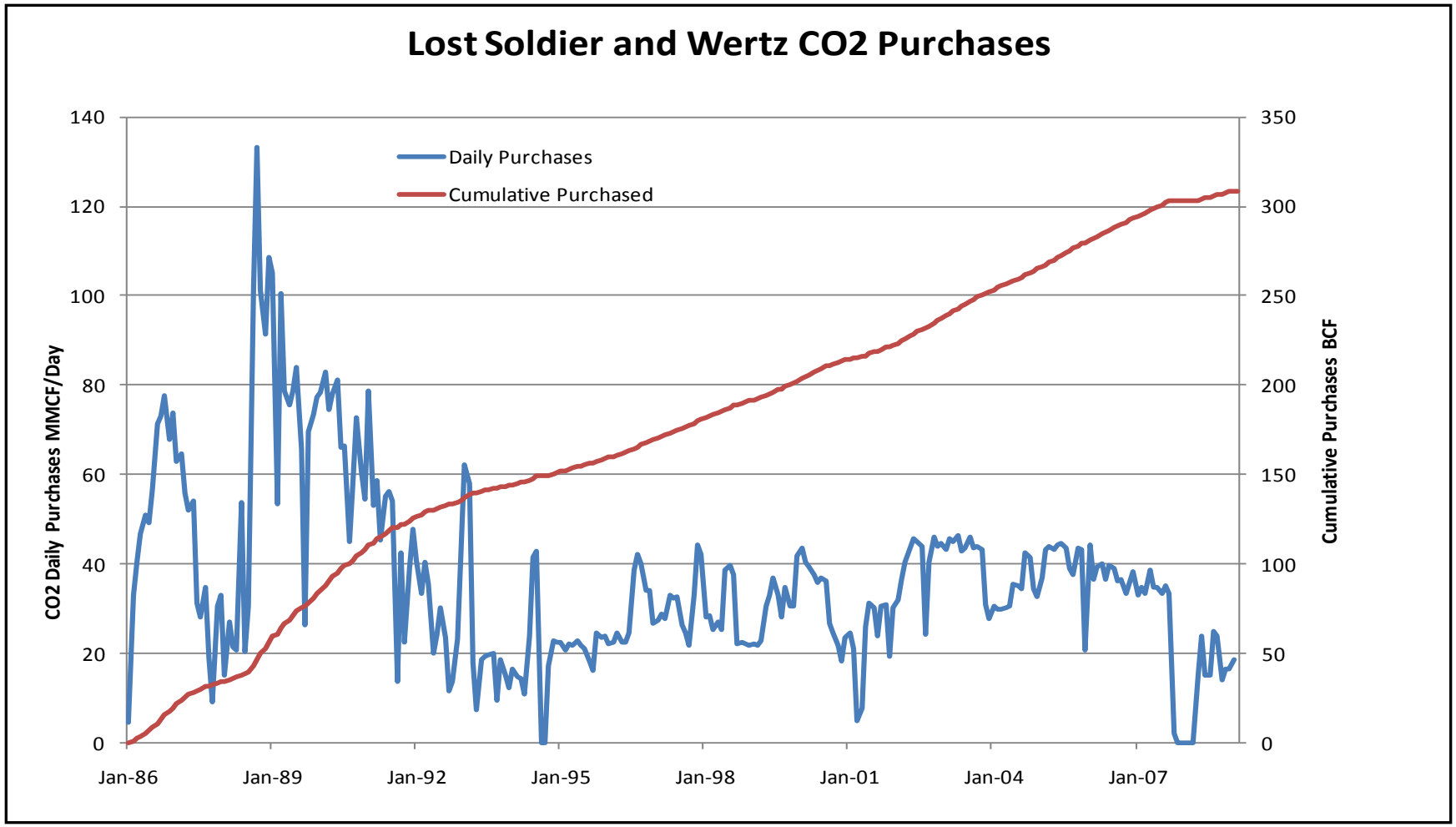
Historical CO_2 Purchases



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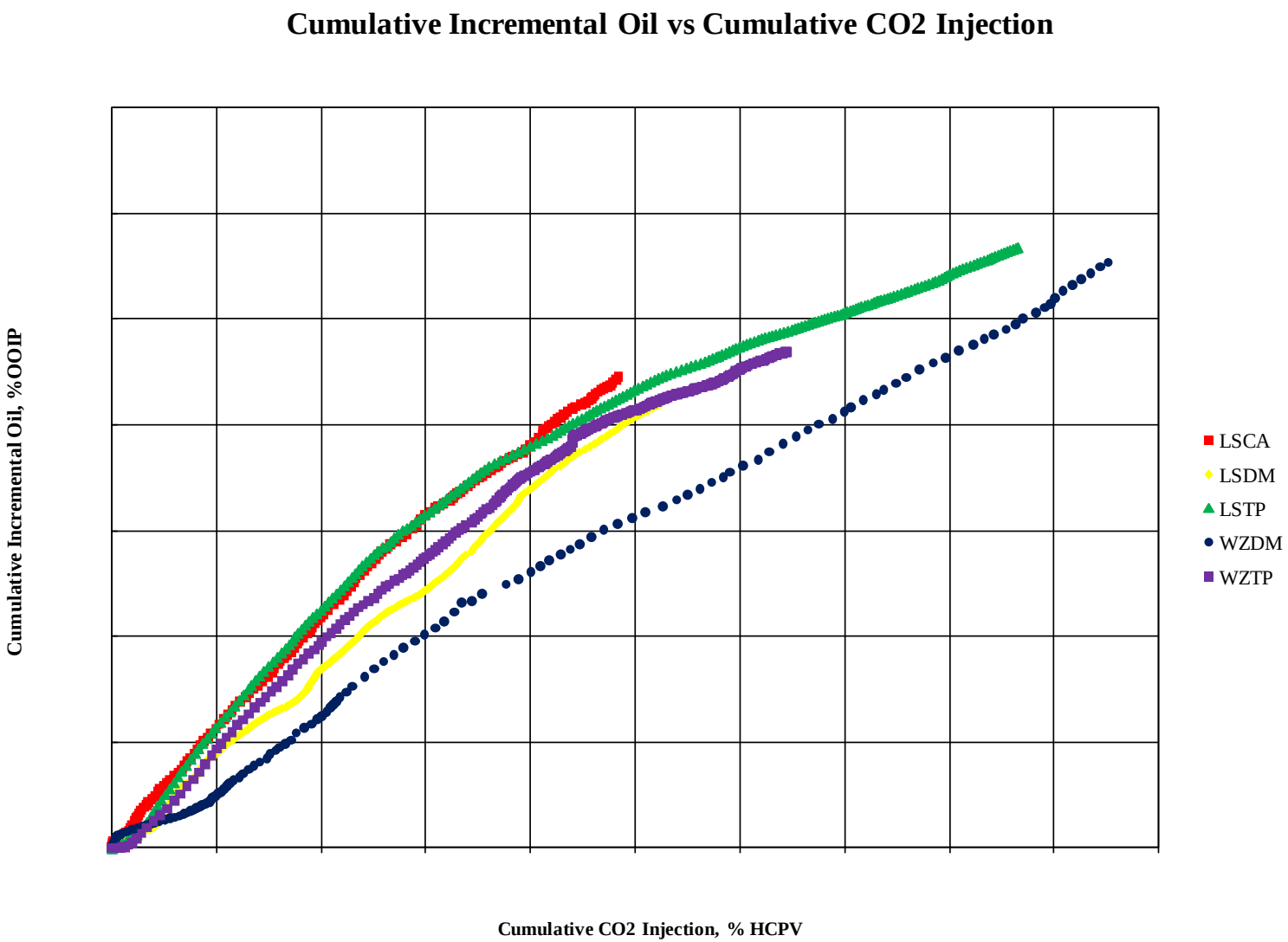
Reservoir Maturity & Recovery



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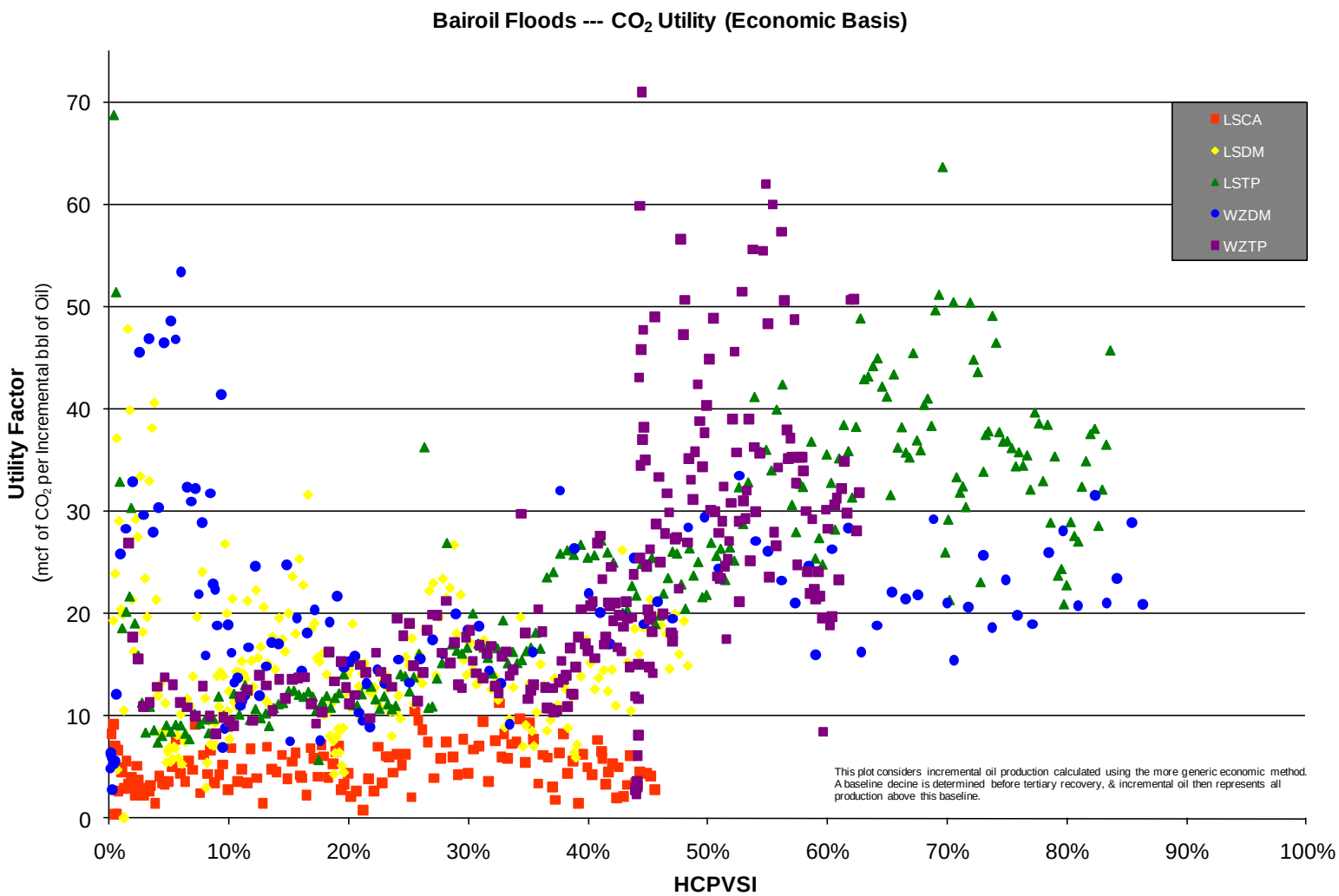
Utility Factor



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CO_2 Allocation Process

Step 1: Review Historical Production/Injection by Reservoir

Step 2: Developed "Ideal CO_2 Injection" at a Pattern Level

Step 3: Combined "Ideal CO_2 Injection" at a Reservoir and Complex level to determine variance with actual constrained volume

Step 4: Revise "Ideal CO_2 Injection" based on constrained CO_2 Volumes at a reservoir and pattern level

Step 5: Finalized WAG schedule & developed WAG management tool

WAG Management Tools

CO_2 Set Points ; Days to C

Flag 0 rates

CO2

Field Set

12/1/2009

Status	Slot #	H2O SETPOINT	H2O Rate	H2O Test Vol	H2O UP STREAM PSI	H2O DOWN STREAM PSI	H2O DESIRED CYCLE VOLUME	H2O CURRENT CYCLE VOLUME	H2O DAYS ON THIS	CO2/H2O SWITCH	CO2 HI RATE LIMIT	CO2 Rate	CO2 Test Vol	CO2 UP STREAM PSI	CO2 DOWN STREAM PSI	CO2 DESIRED CYCLE VOLUME	CO2 CURRENT CYCLE VOLUME	CO2 DAYS ON THIS CYCLE	Flag 0 rates CO2	Flag 0 rates Water	CO OverFlag	H2O OverFlag	WF Set Point Delta	CO2 Set Point Delta
LSU INJ SAT 1																								
LSCA 5	128 - MANUAL	20	4500	0	0	0	0	45000	48621	16	0 - CO2	2500	2440	2199	2042	1853	37500	28247	14.9			4.2		0.0	0.0
LSCA 92	128 - MANUAL	6	2000	0	0	0	0	20000	26588	8	0 - CO2	4000	2311	2298	2007	1808	60000	13824	6.9			20.1		0.0	0.0
LSDM 111	1 - FLOW	5	1500	1577	1580	0	0	15000	4151	3	1 - H2O	3000	0	0	2020	2023	30000	28317	11.0				6.9	0.0	0.0
LSDM 116	128 - MANUAL	13	4000	0	0	0	14	40000	44023	15	0 - CO2	5500	5806	5615	2024	1260	55000	38207	6.9			3.0		0.0	0.0
LSDM 137	128 - MANUAL	2	6250	0	0	0	176	62500	70194	15	0 - CO2	4500	4468	4813	2003	1452	45000	12187	2.8			6.8		0.0	0.0
LSDM 163	128 - MANUAL	8	1500	0	0	0	0	21000	23574	13	0 - CO2	2000	2370	1821	1999	1708	60000	2241	1.8			31.7		0.0	0.0
LSTP 2	128 - MANUAL	4	2100	0	980	0	0	20000	26229	12	0 - CO2	2000	2119	0	2008	1653	20000	1646	0.8	zero CO2				0.0	0.0
LSTP 13	1 - FLOW	18	2000	2086	1916	0	65535	20000	1916	1	1 - H2O	2000	0	638	2108	2003	20000	15361	13.0				9.4	0.0	0.0
LSTP 16	1 - FLOW	10	1000	2286	2300	0	1838	10000	13777	6	1 - H2O	3500	0	0	-1	9	35000	2	0.0				-1.6	0.0	0.0
LSTP 24	1 - FLOW	7	2000	1229	1235	0	1823	20000	9828	8	1 - H2O	2500	0	36464	2036	631	25000	25421	10.0				8.2	0.0	0.0
LSTP 26	128 - MANUAL	19	2000	0	0	0	65535	20000	23908	11	0 - CO2	3500	3085	4158	2036	1259	25000	22118	7.9			0.7		0.0	1666.6
				Total	8011.0	0.0	134921.0	293500.0	292809.0															
				Total	160225.8	301131.8	684360.5	5045000.0	16738222.0															

Reservoir	H2O Set Point	H2O Actual	H2O Target	H2O % Targe	H2O % Target	CO2 Set Point	CO2 Actuals	CO2 Target	CO2 % Target	CO2 % Target	WAG	CO OverFlag	OverFl ag
LSTP	76650	65584	40000	0.86	1.64	74000	89378	55000	1.2	1.63	1.54	<0	
LSDM	28875	19024	36000	0.66	0.53	34250	33665	30000	1.0	1.12	1.19		<0
LSCA	14000	8400	9000	0.60	0.93	18750	12647	16000	0.7	0.79	1.40		
LSLA	150	296				0	0						
LSMU	0	0				0	0						
WZTP	46250	37638	70000	0.81	0.54	33675	25286	22000	0.8	1.15	3.13		
WZDM	30250	29284	25000	0.97	1.17	30750	24664	27000	0.8	0.91	2.50		
Lost Soldier	119675	93304	85000	0.77964	1.10	127000	135691	101000	1.1	1.34	1.45		
Wertz	76500	66922	95000	0.8748	0.70	64425	49950	49000	0.8	1.02	2.82		
Grand Total	196175	160226	180000	0.81675	0.89	191425	185641	150000	1.0	1.24	1.82		

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Before & After WAG

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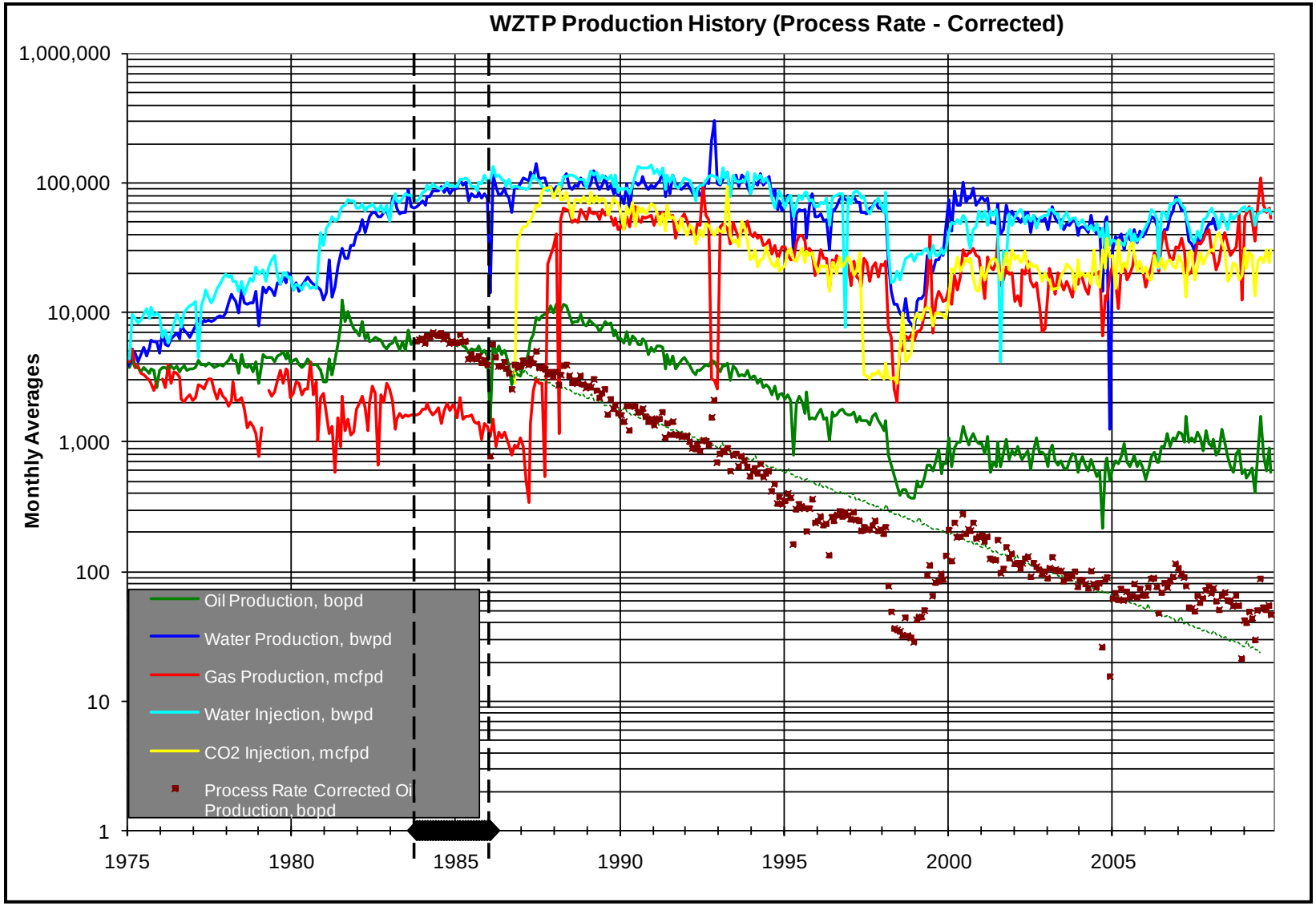
Wertz Tensleep



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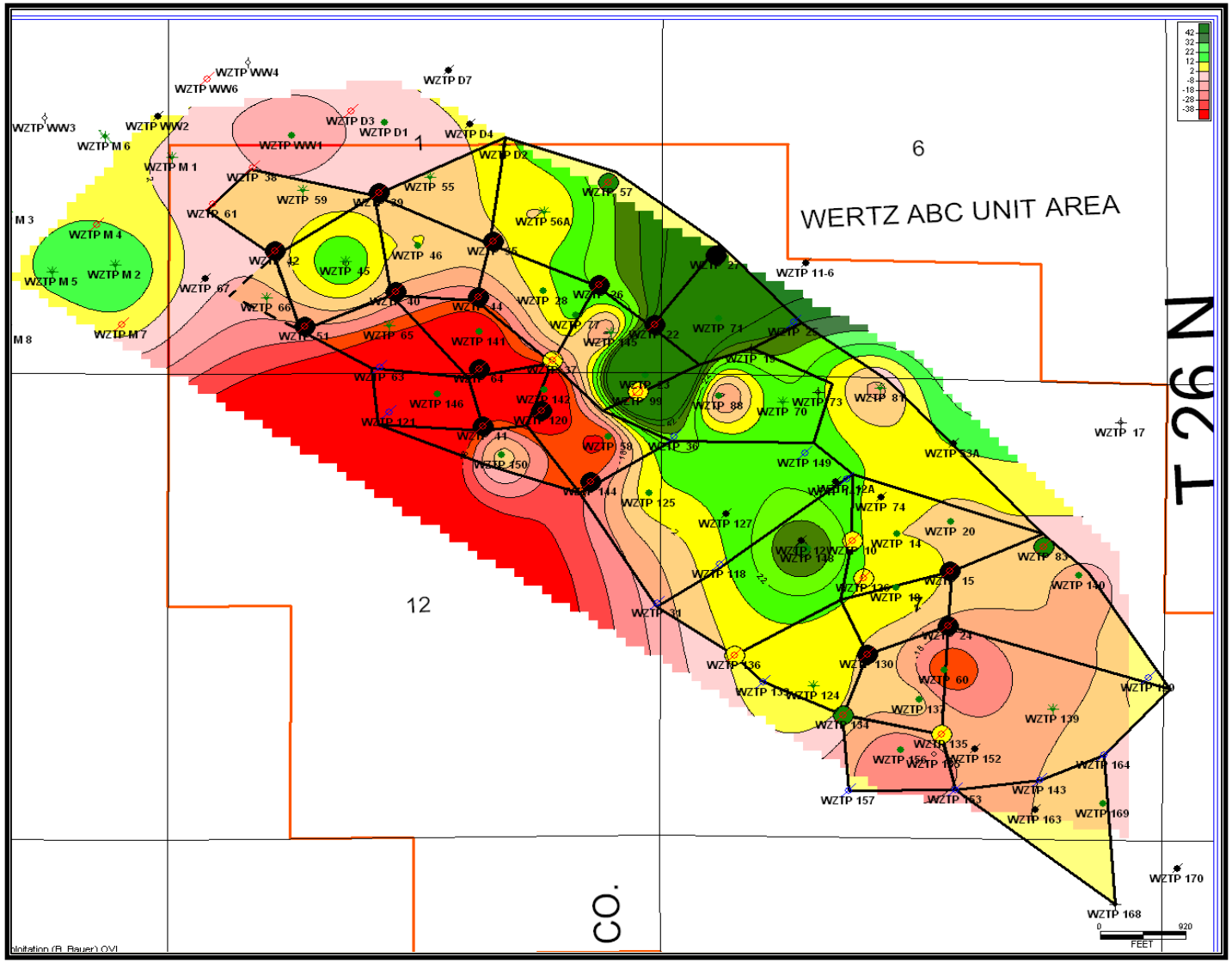
Production Impact



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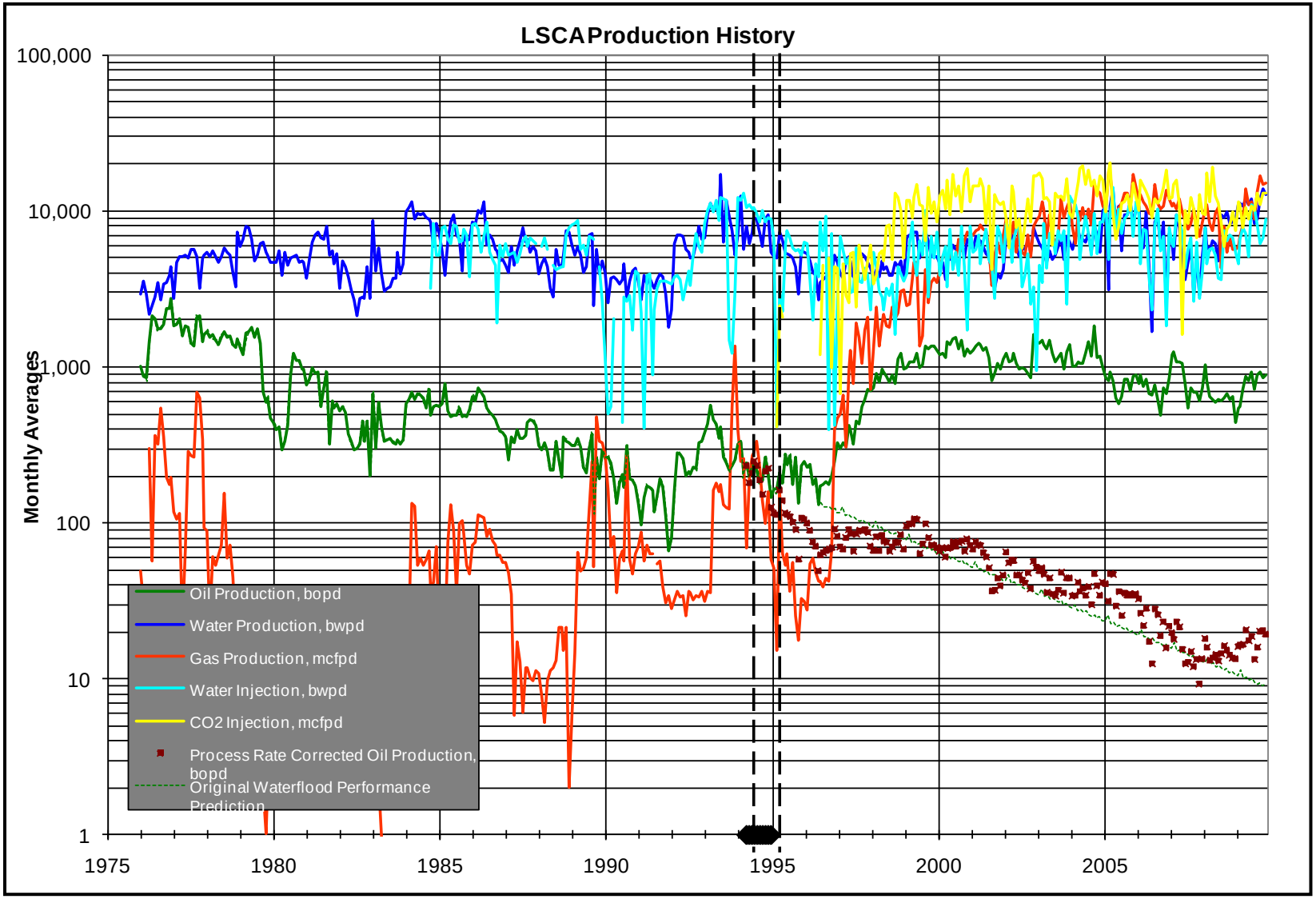
Lost Soldier Cambrian



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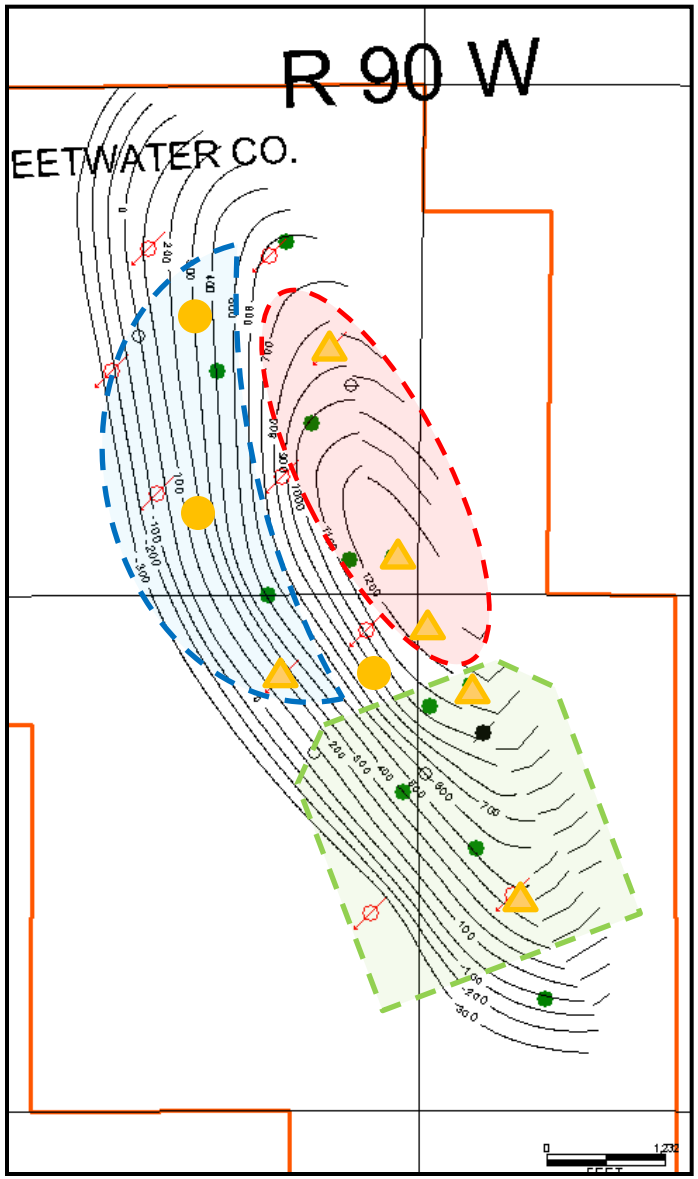
Phased Map of Cambrian DownSpacing



Phase I

LSCA 10 – Convert to injection
LSTP 89 - Deepen well & convert to injection
LSDM 156 – Deepen well & convert to injection

Phase II

LSCA 53 – Horizontal Sidetrack & convert to injection.
LSCA 234 – New Horizontal Producer
LSCA 233H – New Vertical Producer

Phase III

LSCA 120 – Convert to producer
LSCA 49 – Convert to injector
LSCA 108 – Horizontal Sidetrack Injector
LSCA 235 – New Horizontal Producer

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Future Challenges

- Identifying best methods to improve reservoir conformance
  - Working with Dow & reviewing polymer/gel treatments
- CO_2 Recycling Capacity
  - Installing additional compression capacity
- Water Disposal Capacity
  - Identifying reservoirs for waterflood, disposal candidates
- Maximizing CO_2 Utilization