



Cook Inlet Natural Gas Reserves Study

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Geophysical Society of Alaska Joint Meeting

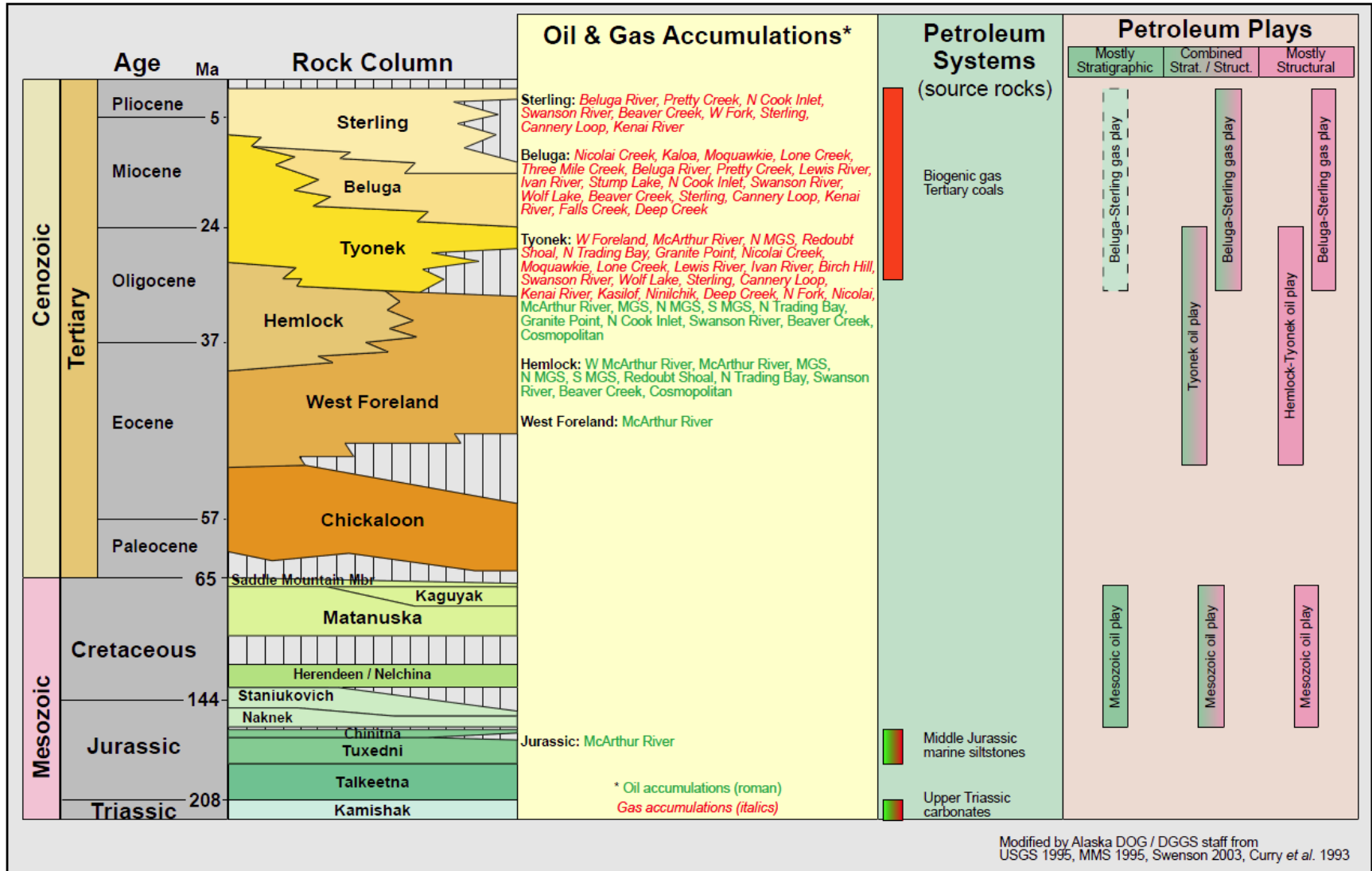


Overview

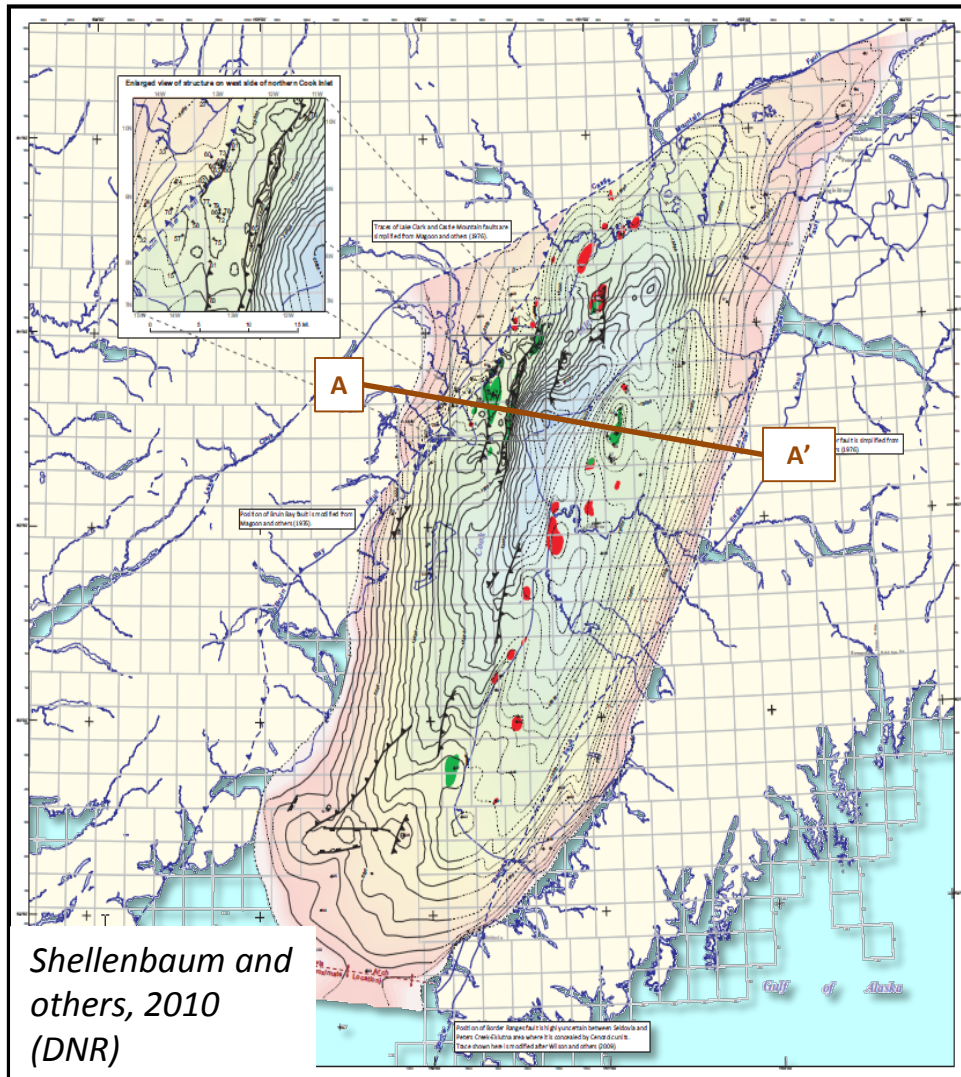
- Geological Setting of Cook Inlet
- Historical Trends
- Assumptions
 - Decline analysis
 - Material balance
- Discussion



Cook Inlet Stratigraphic Column

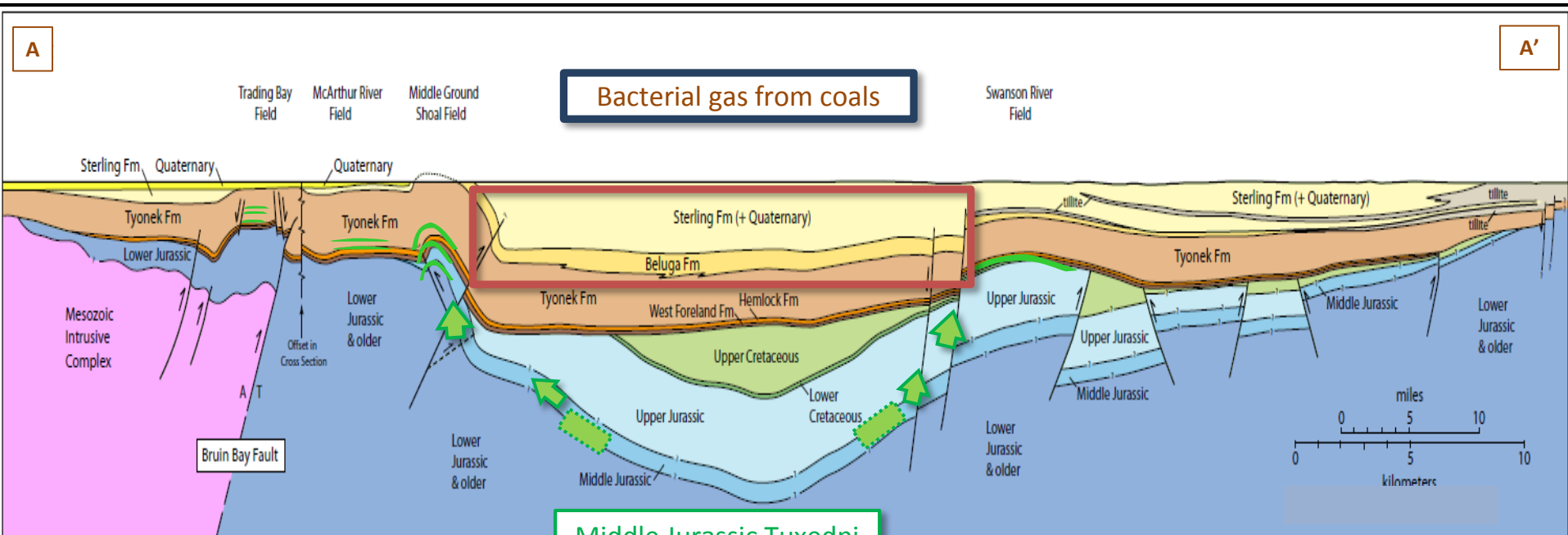


Cook Inlet Basin



- Coal-sourced biogenic gas in Sterling, Beluga, and Tyonek
- Thermogenic oil from Jurassic source in Hemlock and lower Tyonek Formations
- Most large structures have been drilled
- Smaller structural traps and perhaps numerous stratigraphic traps remain to be discovered
- Inaccessible lands
- Map shows base of Tertiary structure

Cook Inlet Petroleum Systems



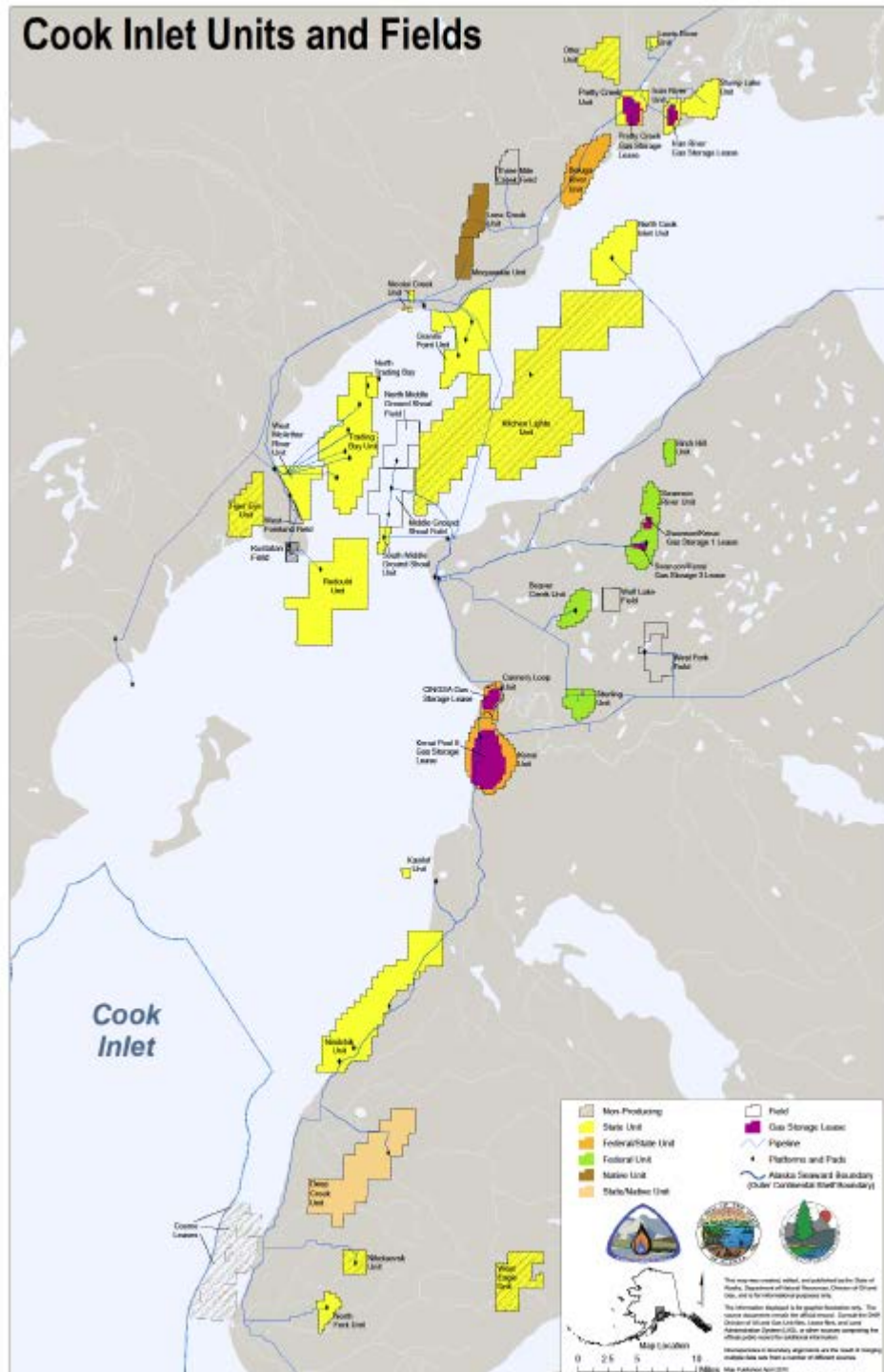
Bacterial gas from coals

Middle Jurassic Tuxedni source rocks at oil window maturity

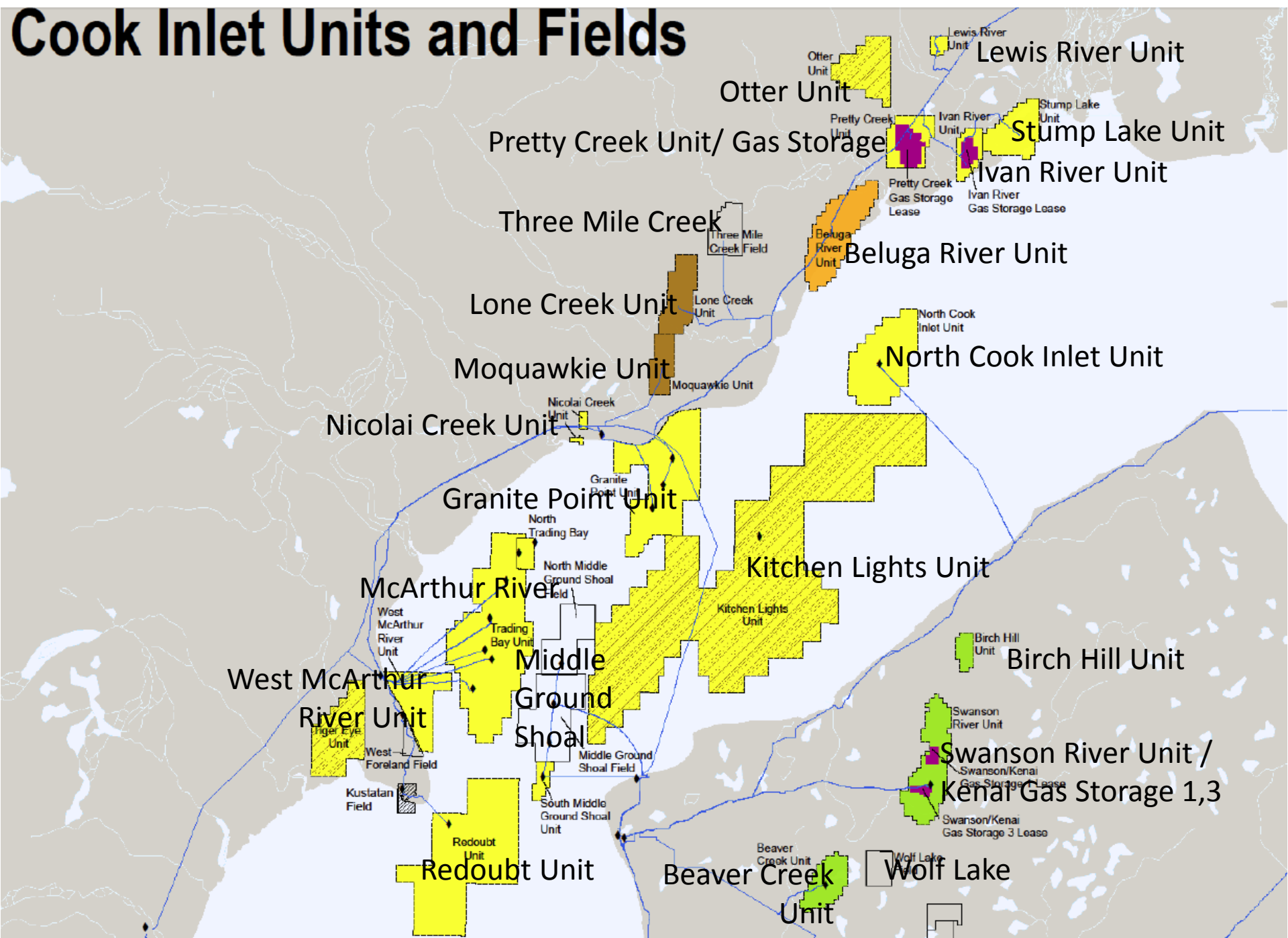
Modified from Hauessler and others (2000), revised from Boss and others (1976)

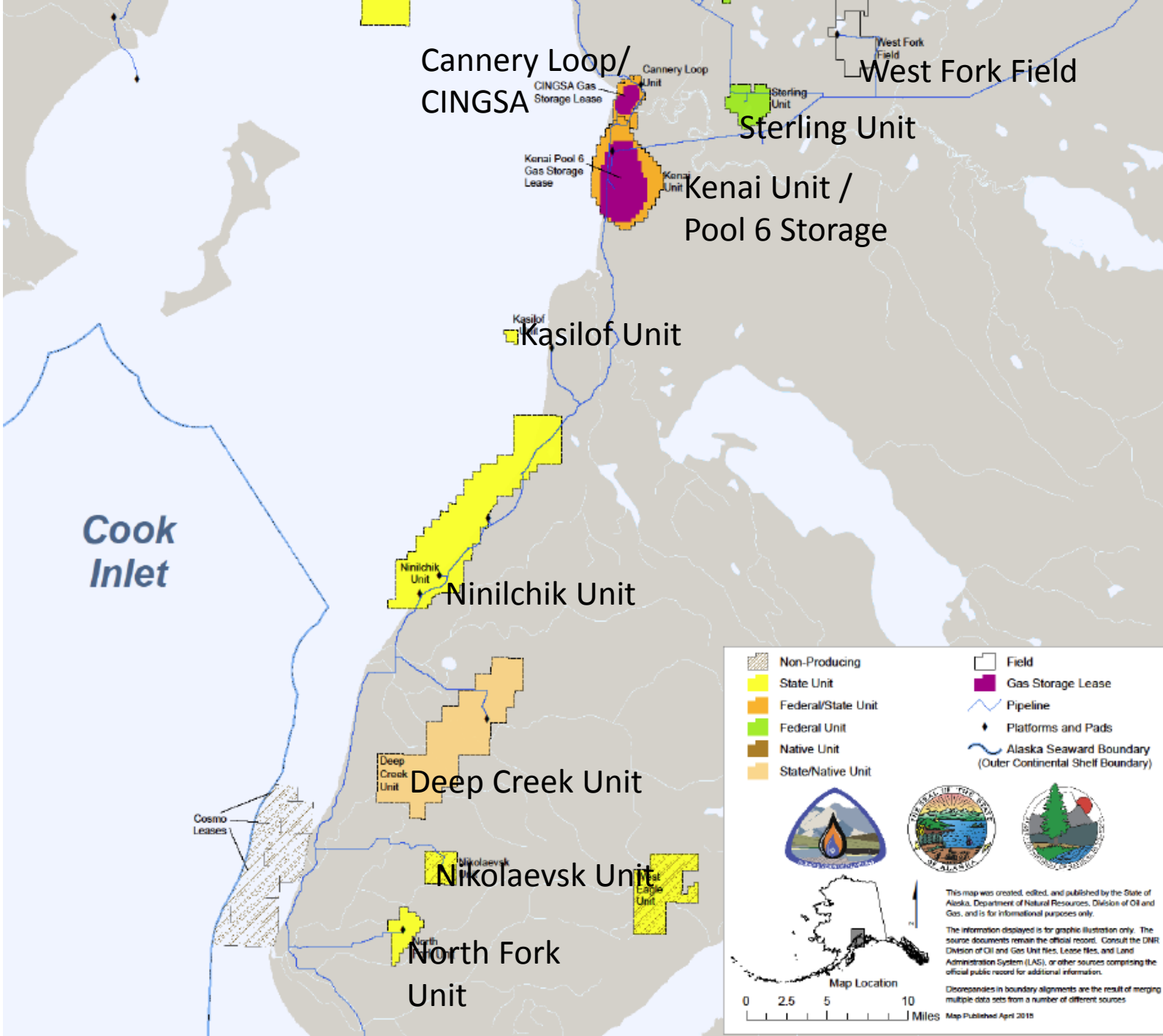


Cook Inlet Units and Fields






Cook Inlet Units and Fields





Non-Producing	Field
State Unit	Gas Storage Lease
Federal/State Unit	Pipeline
Federal Unit	Platforms and Pads
Native Unit	Alaska Seaward Boundary (Outer Continental Shelf Boundary)
State/Native Unit	

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The information displayed is for graphic illustration only. The source documents remain the official record. Consult the DNR Division of Oil and Gas Unit Files, Lease Files, and Land Administration System (LAS), or other sources comprising the official public record for additional information.

Discrepancies in boundary alignments are the result of merging multiple data sets from a number of different sources.

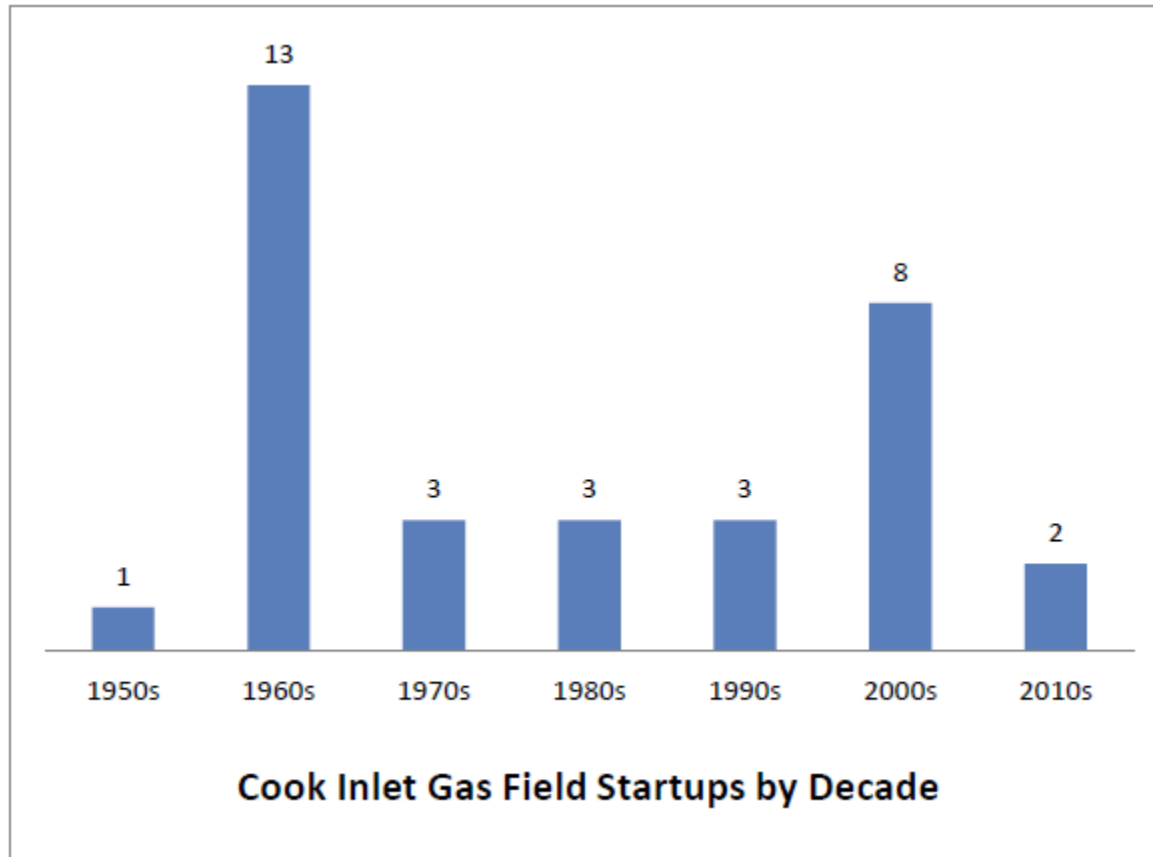
Map Location

0 2.5 5 10 Miles

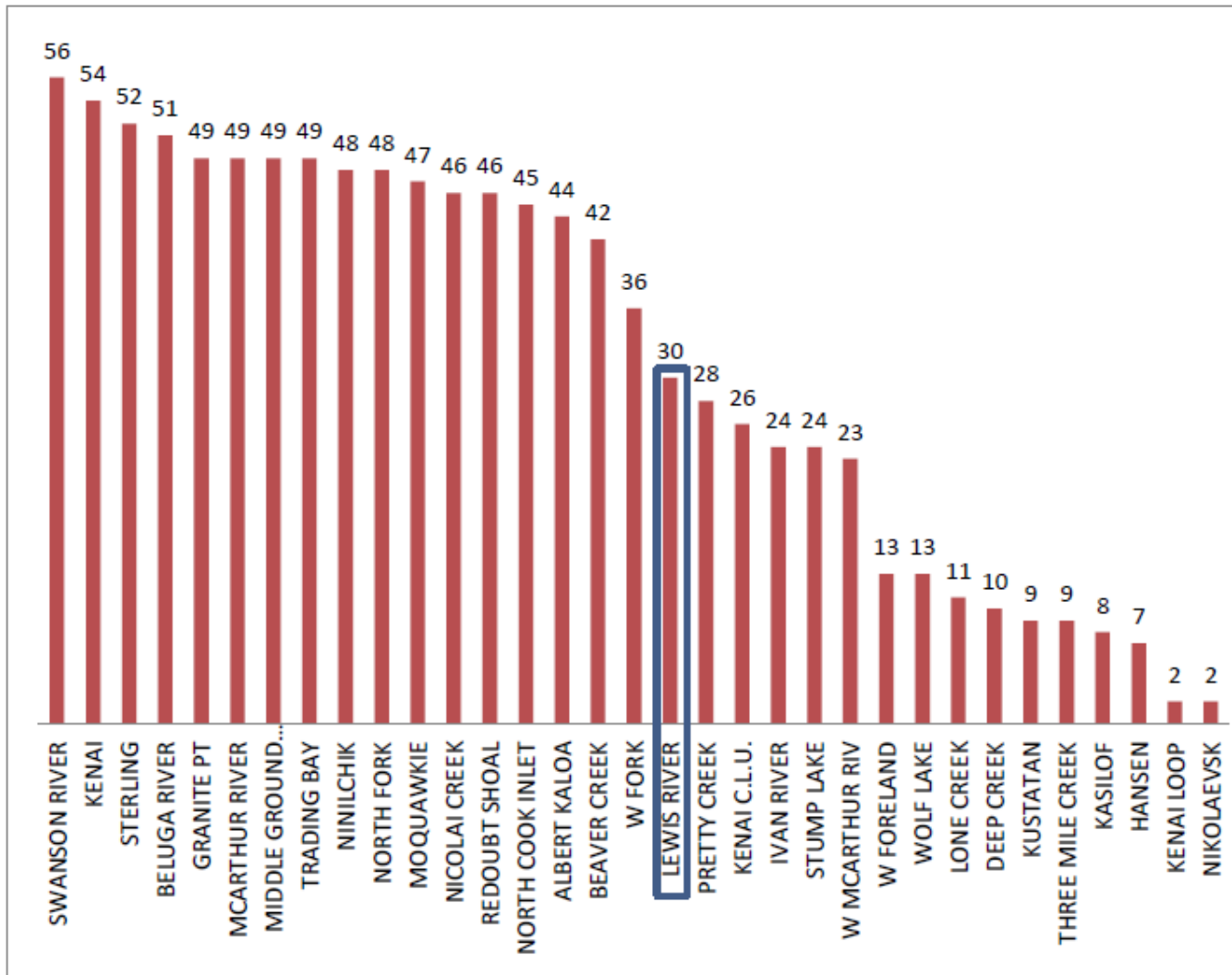
Map Published April 2015



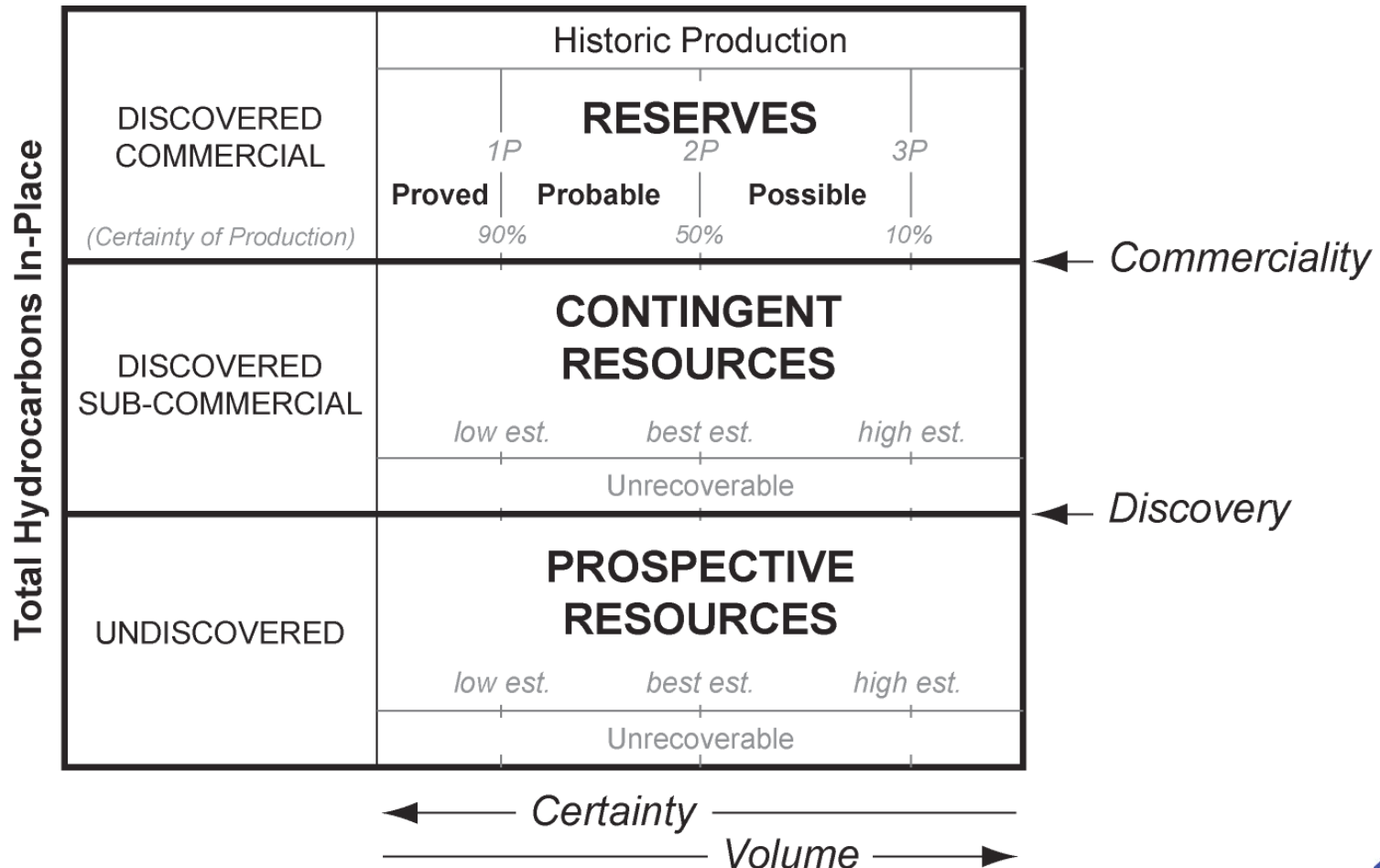
Gas Field Startups: Includes Production Tests



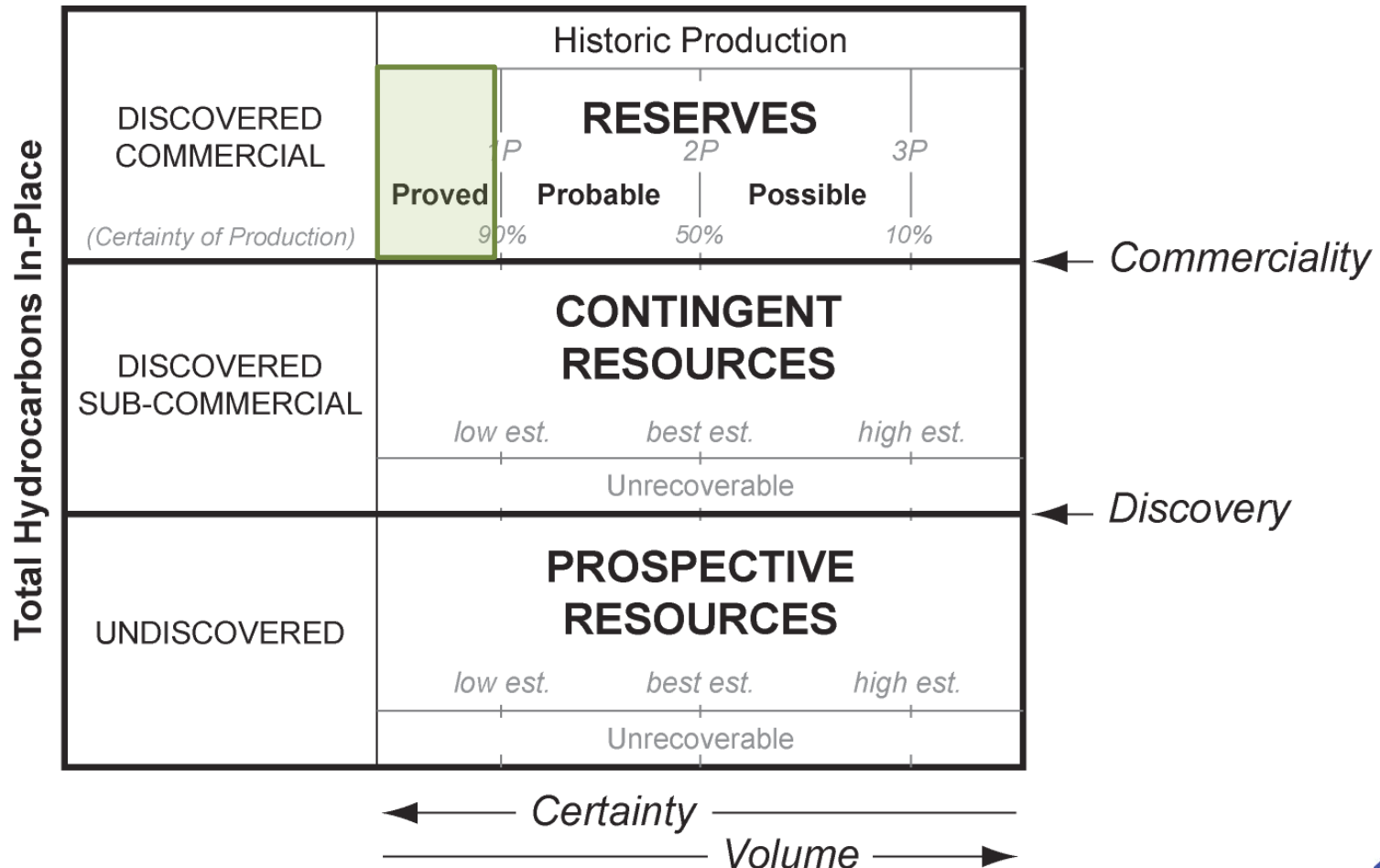
Average age of fields = 30 years



Petroleum Resources Management System



Petroleum Resources Management System

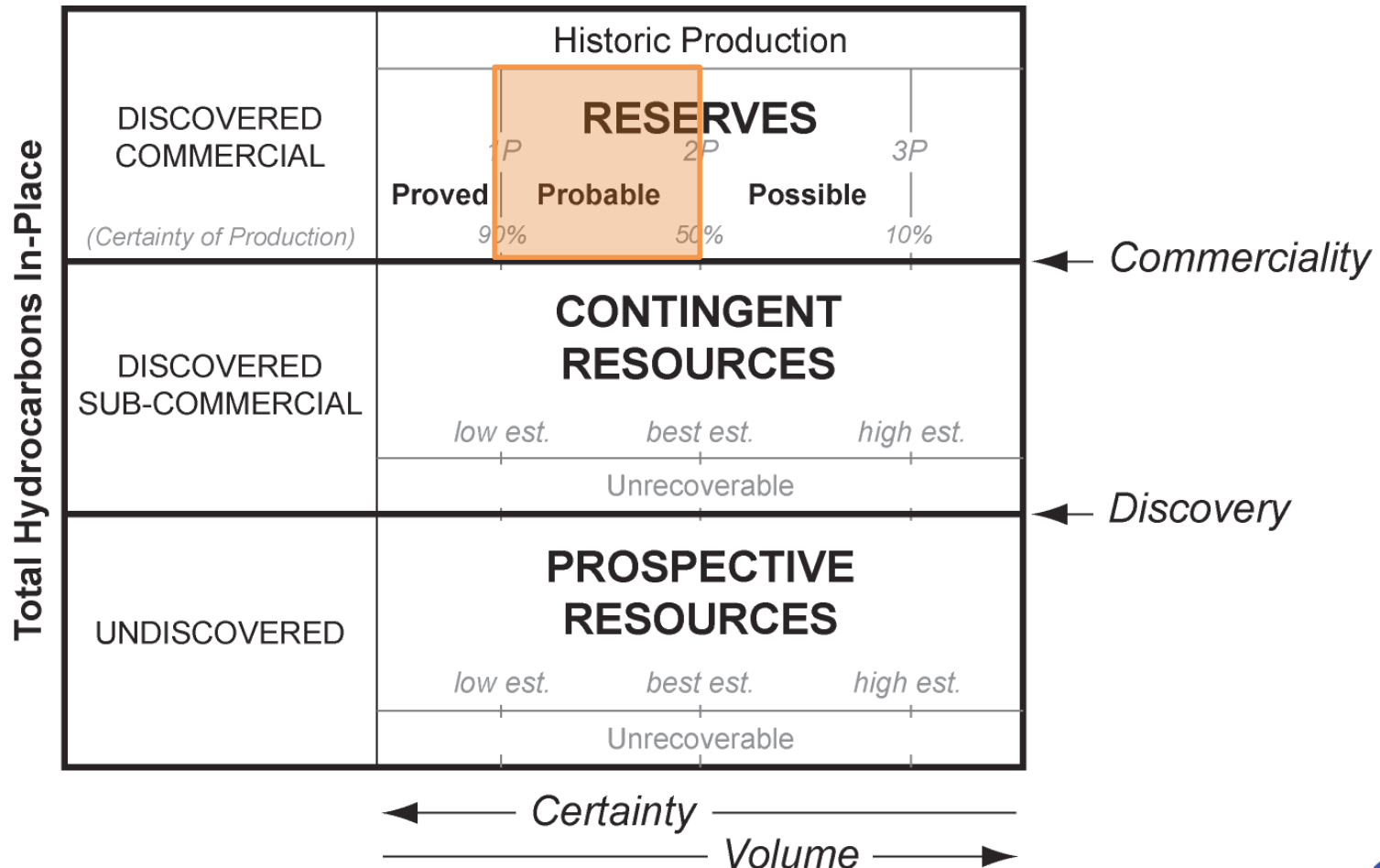


Breakdown of Reserves for Cook Inlet Study

- **Proved Reserves (1P) =**
Well-Level Decline Curve Analysis for Gas
+
Pool-Level Decline Curve Analysis for
Associated Gas



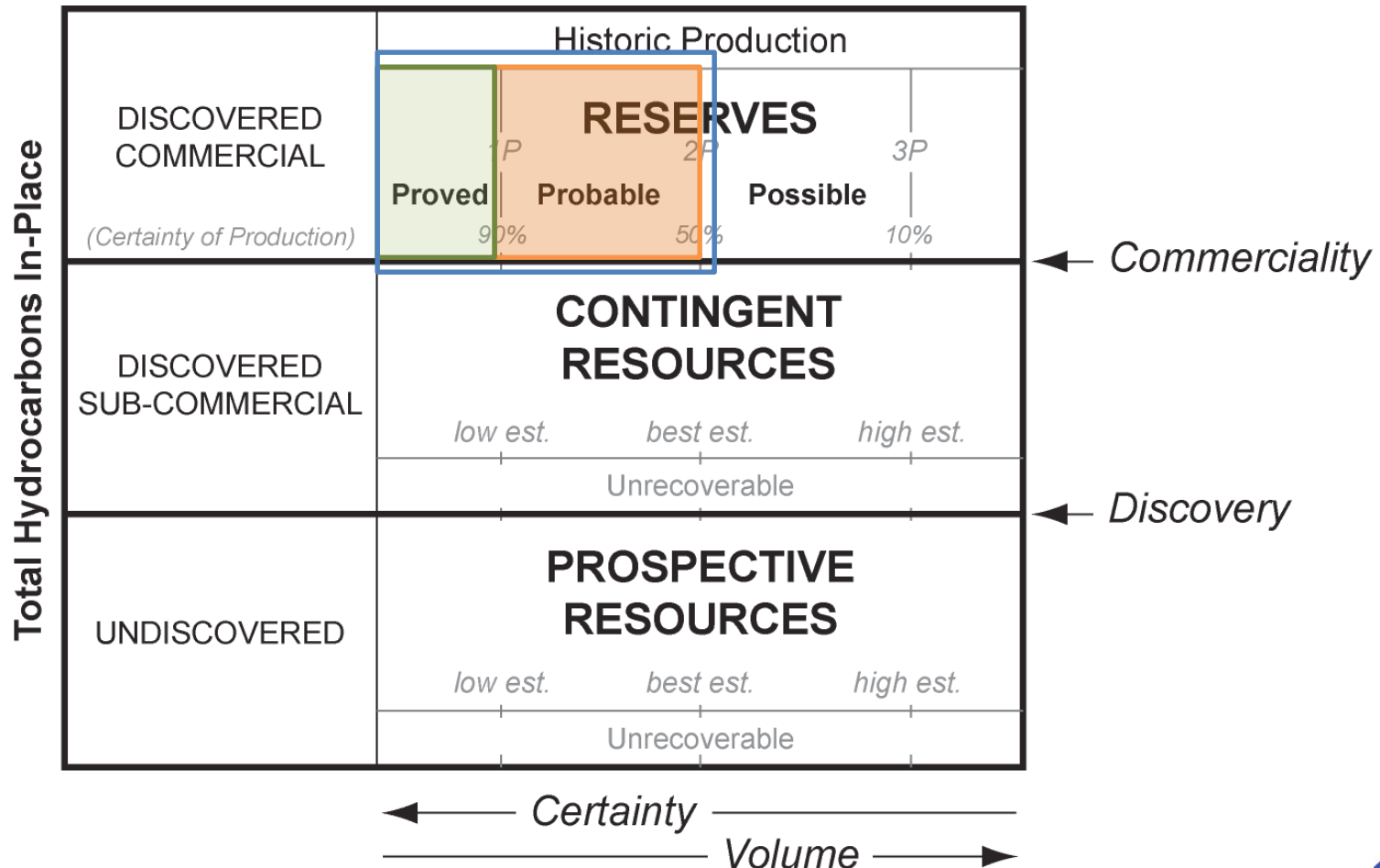
Petroleum Resources Management System



Breakdown of Reserves for Cook Inlet Study

- Probable Reserves =
Upside Well Level Decline Curve Analysis for Gas
+
Material Balance

Petroleum Resources Management System



Breakdown of Reserves for Cook Inlet Study

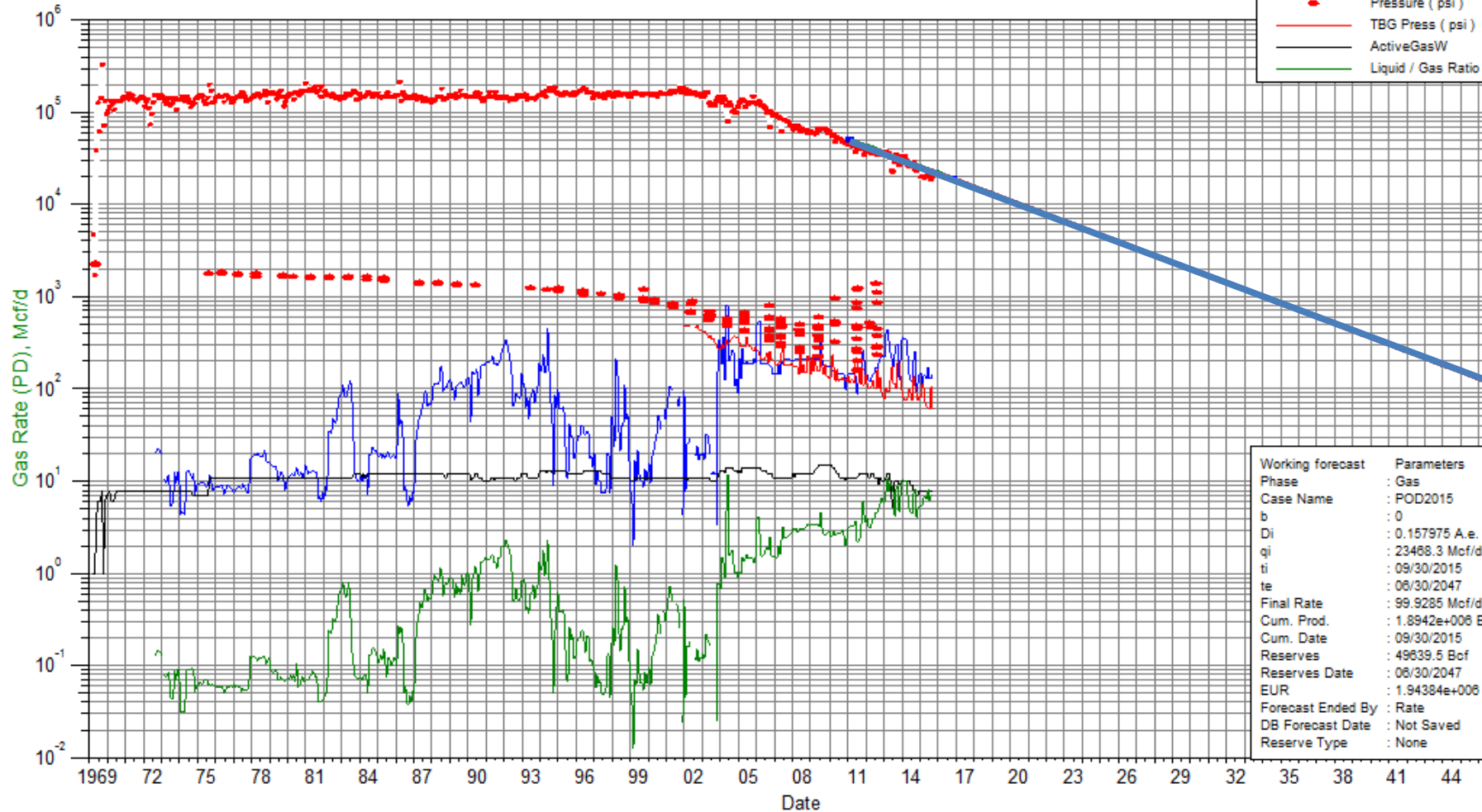
- **Proved Reserves (1P) =**
Well-Level Declines for Gas +
Pool-Level Decline for Associated Gas
 - + - **Probable Reserves =**
Upside Well Level Declines for Gas +
Material Balance
- = 2P (Proved + Probable) Reserves



Decline Analysis: North Cook Inlet

Completion PoolName: NORTH COOK INLET, TERTIARY GAS Pool: NORTH COOK INLET, TERTIARY GAS Current Status: <Ambiguous>

Operator: CON-PHIL

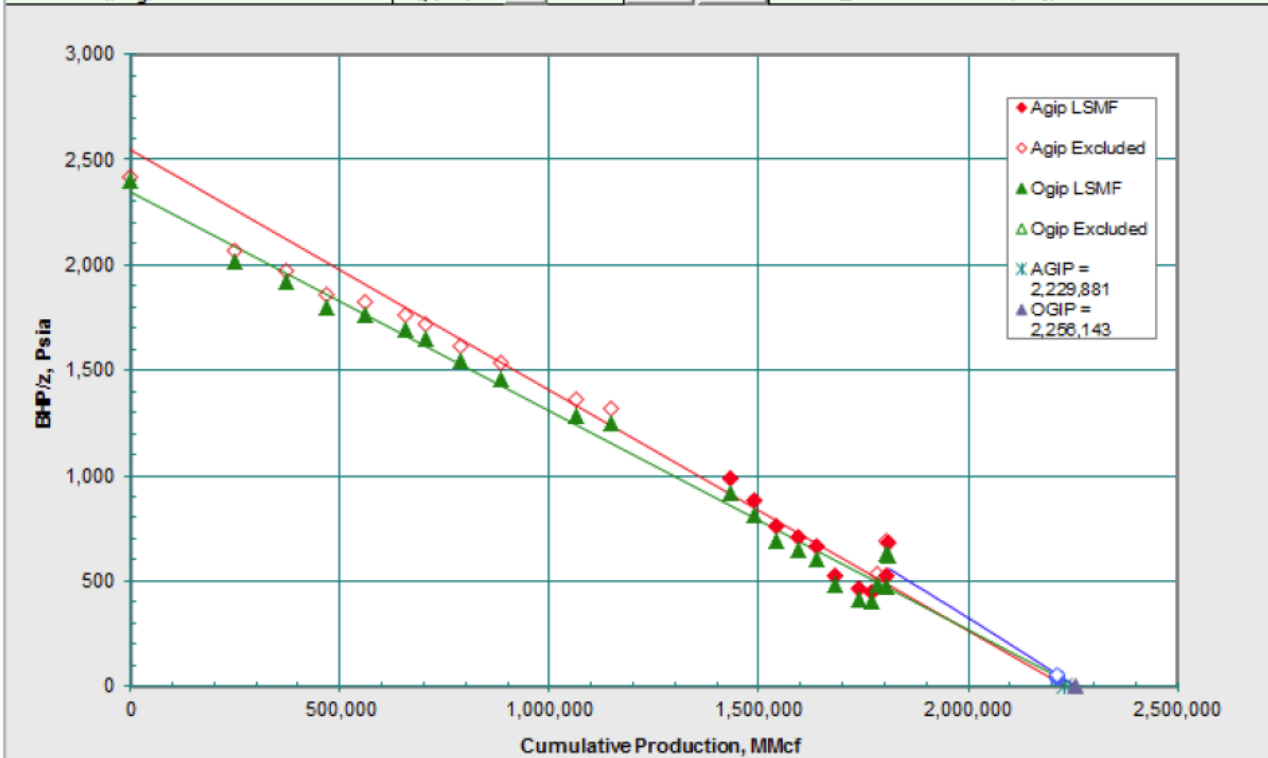


NORTH COOK INLET, TERTIARY GAS
 — Water Rate (PD) ()
 • Pressure (psi)
 — TBG Press (psi)
 — ActiveGasW
 — Liquid / Gas Ratio

Working forecast	Parameters
Phase	: Gas
Case Name	: POD2015
b	: 0
Di	: 0.157975 A.e.
qi	: 23468.3 Mcf/d
ti	: 09/30/2015
te	: 06/30/2047
Final Rate	: 99.9285 Mcf/d
Cum. Prod.	: 1.8942e+006 B
Cum. Date	: 09/30/2015
Reserves	: 49639.5 Bof
Reserves Date	: 06/30/2047
EUR	: 1.94384e+006
Forecast Ended By	: Rate
DB Forecast Date	: Not Saved
Reserve Type	: None

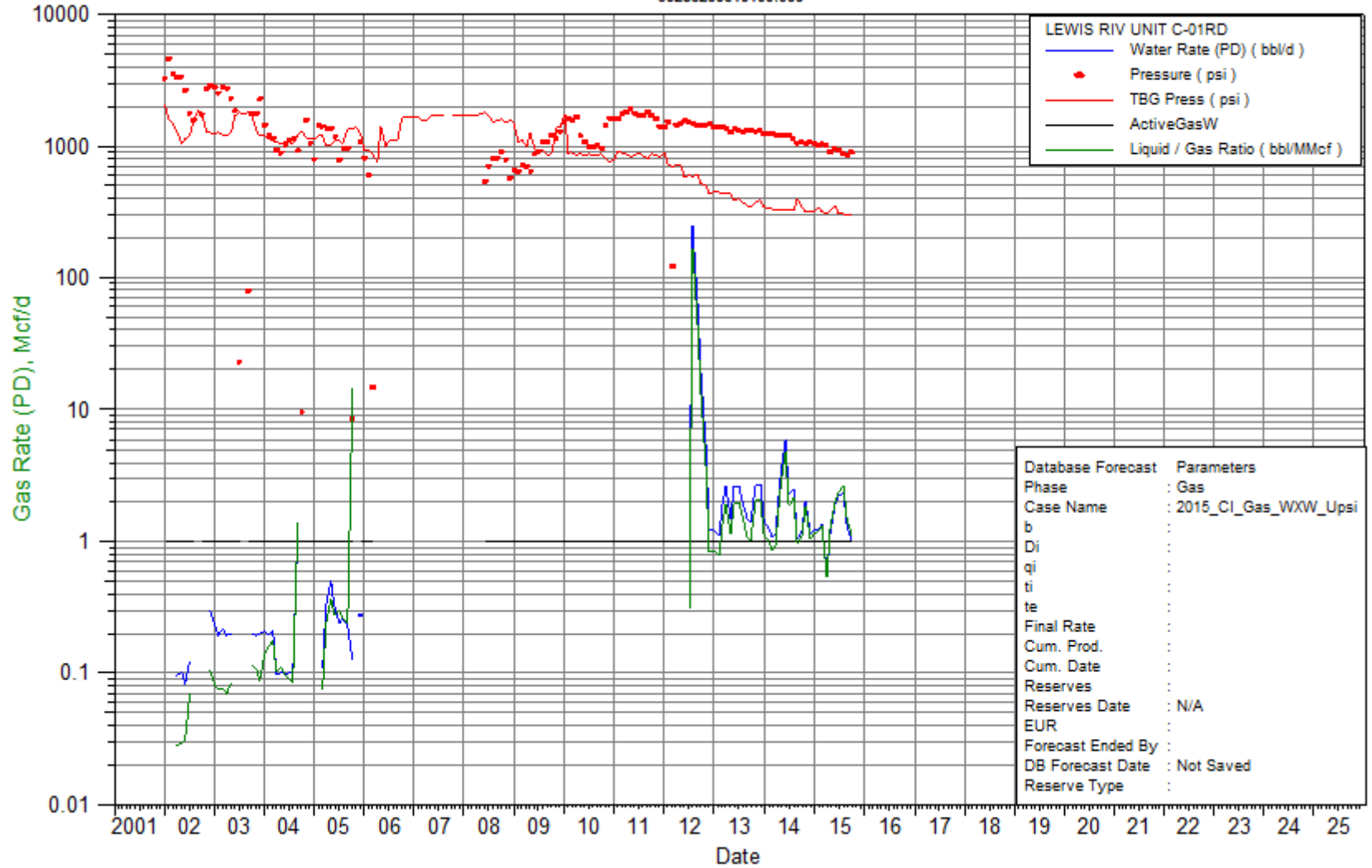
Material Balance: North Cook Inlet

WELL NAME:				Ryder Scott Reservoir Solutions 6.0 (Public) (Protected)			
FIELD: North Cook Inlet							
COUNTY, STATE: Reservoir Engineer: Islin Munisteri, May 27, 2015							
RESERVOIR: Tyonek (Tertiary Gas pool) (Comp from NCIU A-15) (alphanumeric)							
* Wichert-Aziz correction for contaminants, if any							
WELLHEAD TEMP, °F:	36.0	SOUR GAS	MOLE %	Print Options	Calc AGIP	Least Squares Mean Fit Results Y-Intercept, BHP/z 2,551 Apparent GIP, MMCF 2,229,881 OGIP, MMCF 2,256,143	
BOTTOMHOLE TEMP, °F:	109.0	N ₂	0.25				
WET GAS GRAVITY: ??	0.565	CO ₂	0.25	Hide Graph	Calc OGIP	EUR, MMCF 2,213,844	
TVD, FEET:	4,200	H ₂ S	0.00				
COND. CORR.? (Y/N):	N	Formation Properties		New Form	Calc EUR	Recovery Factor 0.9813	
Corrected* Tc, °R:	346.24	S _w (dec)	0.40				
Corrected* Pc, Psia:	673.09	C _w , μsip ??	3.00				
V _w /V _g , AcFt/AcFt:	5.00	C _f , μsip ??	3.17			BHP/z @ Abandonment (Adj) 44	



Completion LEWIS RIV UNIT C-01RD Pool: LEWIS RIVER, UNDEFINED GAS Current Status: 1-GAS

Operator: HILCORP
50283200610100:500



Decline Curve Analysis (Exponential)

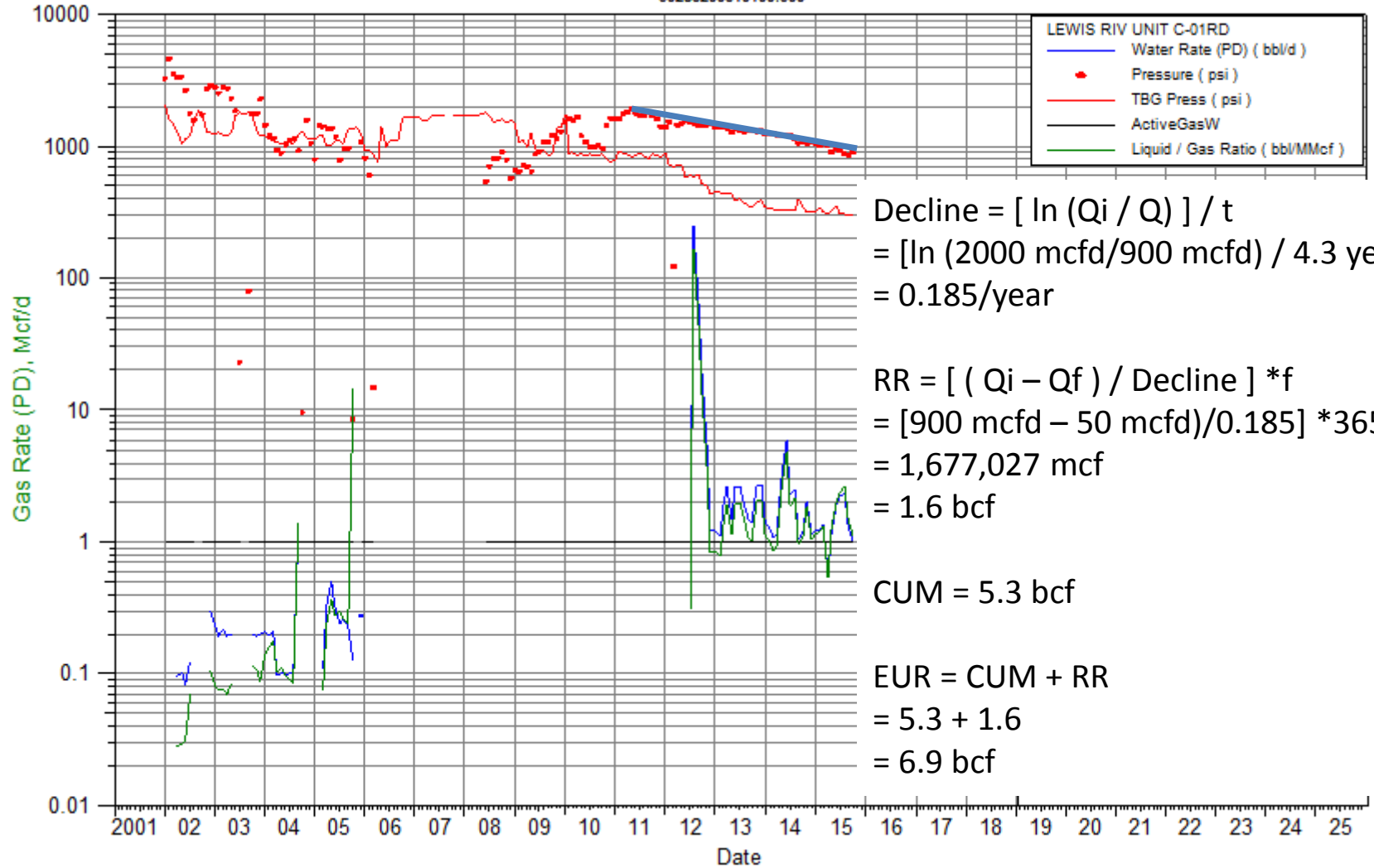
- Decline = $[\ln (Q_i / Q)] / t$
- Remaining Reserves as of 9/30/2015 onwards = $[(Q_i - Q_f) / \text{Decline}] * f$

- T = time, months
- Decline = nominal decline, gas rate / month
- Q_i = initial gas rate, mcf/d
- Q_f = final gas rate = 50 mcf/d



Completion LEWIS RIV UNIT C-01RD Pool: LEWIS RIVER, UNDEFINED GAS Current Status: 1-GAS

Operator: HILCORP
50283200610100:500



$$\text{Decline} = [\ln (Q_i / Q_f)] / t$$

$$= [\ln (2000 \text{ mcf/d} / 900 \text{ mcf/d})] / 4.3 \text{ years}$$

$$= 0.185 / \text{year}$$

$$\text{RR} = [(Q_i - Q_f) / \text{Decline}] * f$$

$$= [900 \text{ mcf/d} - 50 \text{ mcf/d}] / 0.185 * 365$$

$$= 1,677,027 \text{ mcf}$$

$$= 1.6 \text{ bcf}$$

$$\text{CUM} = 5.3 \text{ bcf}$$

$$\text{EUR} = \text{CUM} + \text{RR}$$

$$= 5.3 + 1.6$$

$$= 6.9 \text{ bcf}$$



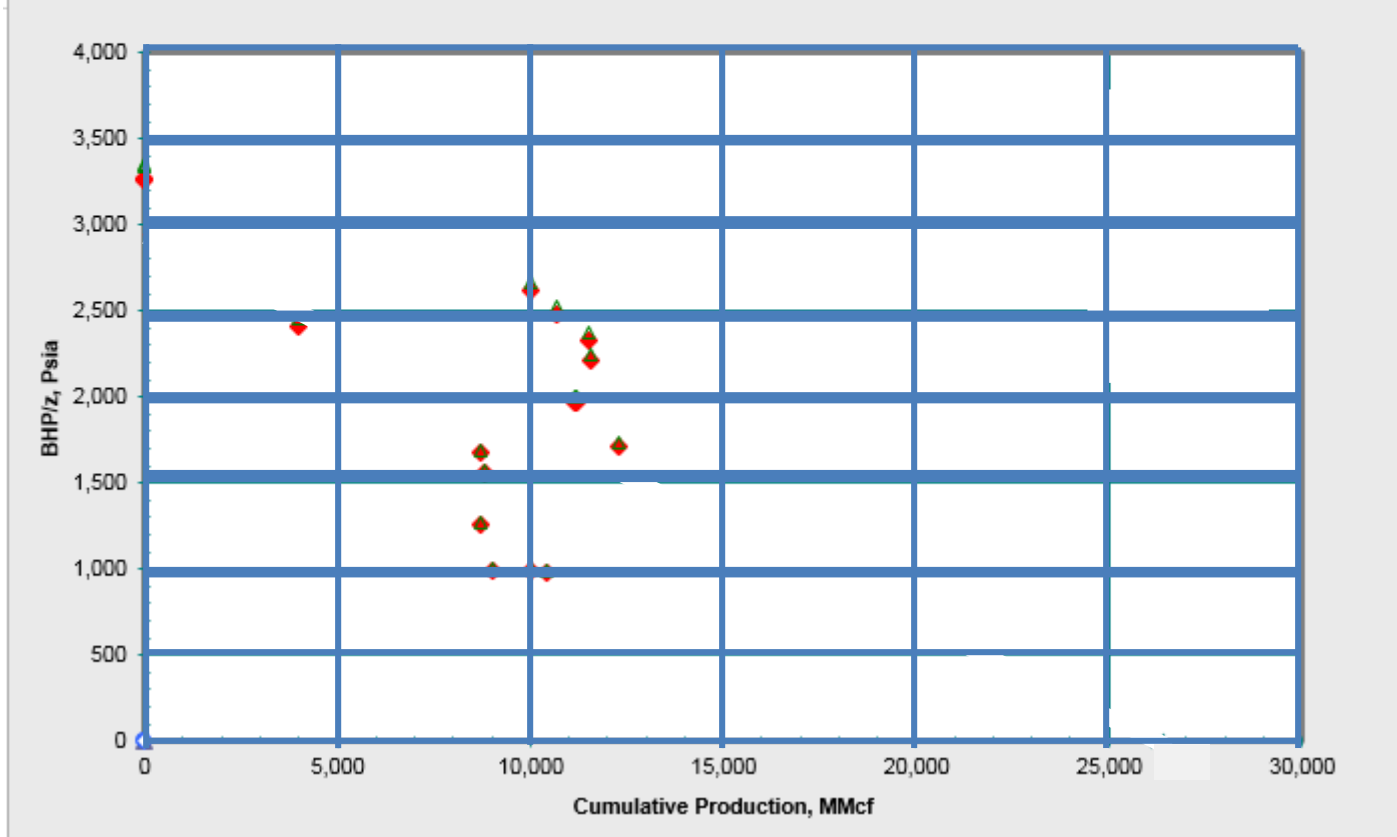
WELL NAME:	
FIELD:	Lewis River
COUNTY, STATE:	
RESERVOIR:	(alphanumeric)


Ryder Scott
Reservoir
Solutions 6.0
(Public)
(Protected)

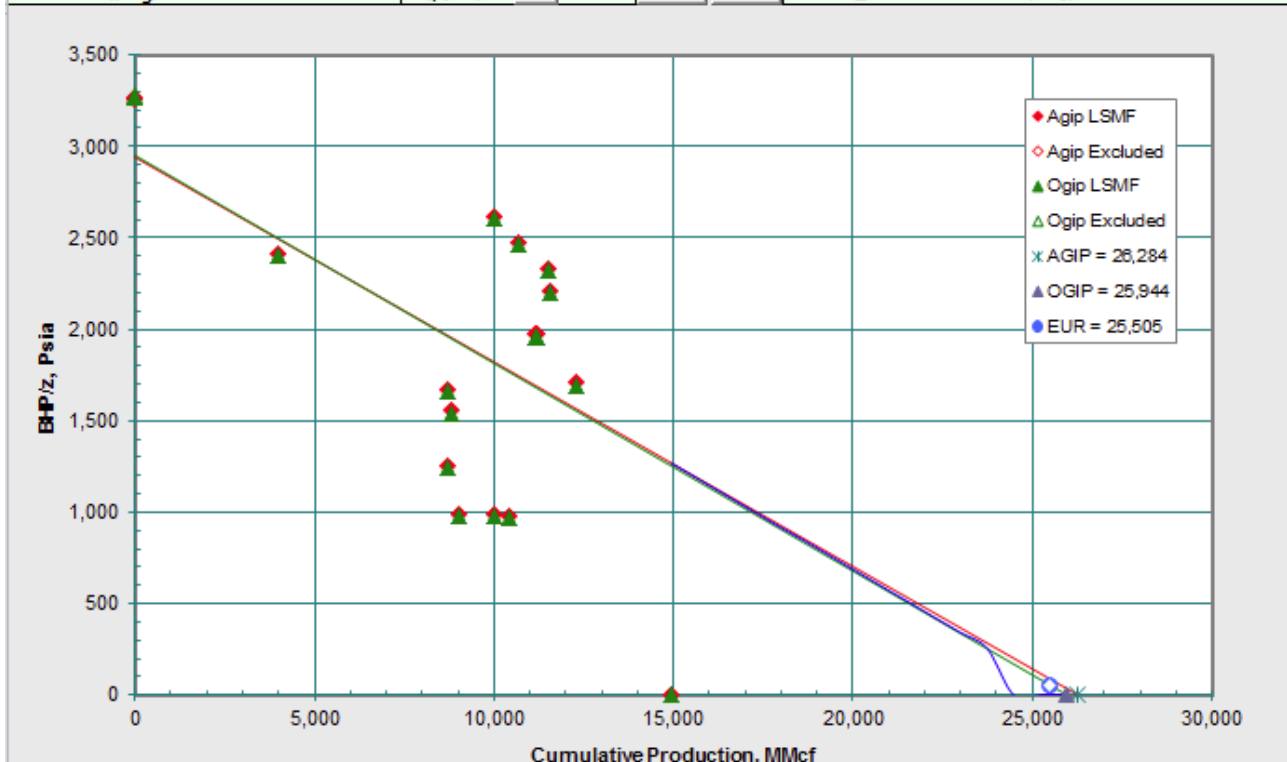


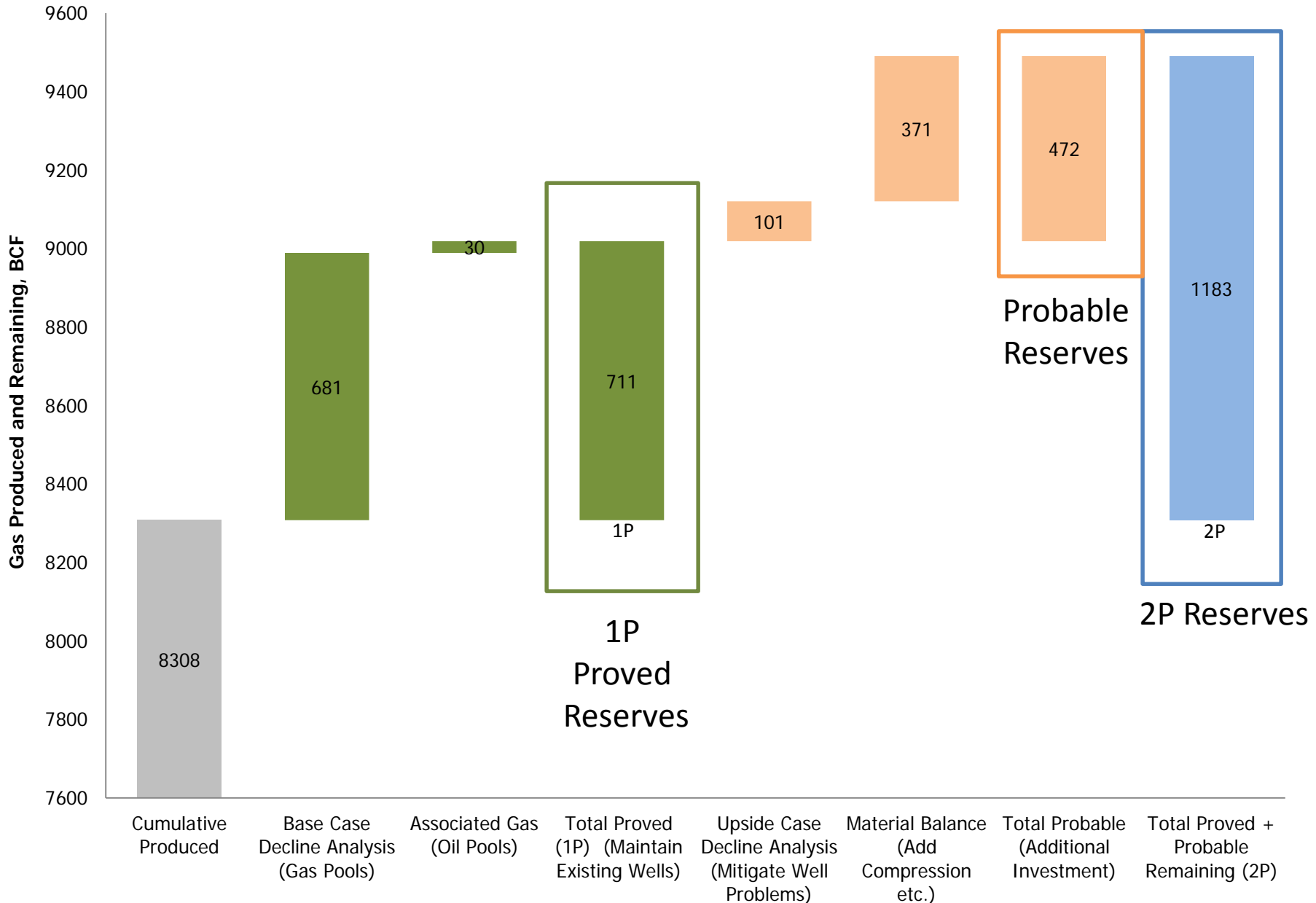
* Wichert-Aziz correction for contaminants, if any

WELLHEAD TEMP, °F:	36.0	SOUR GAS	MOLE %	Print Options	Calc AGIP
BOTTOMHOLE TEMP, °F:	111.0	N ₂	0.00		
WET GAS GRAVITY:	??	CO ₂	0.00	Hide Graph	Calc OGIP
TVD, FEET:		H ₂ S	0.00		
COND. CORR.? (Y/N):	N	Formation Properties			New Form
Corrected* Tc, °R:		S _w (dec)	0.45		
Corrected* Pc, Psia:		C _w , μsip	?? 3.00		
V_w/V_g, AcFt/AcFt:		C _f , μsip	?? 3.51		



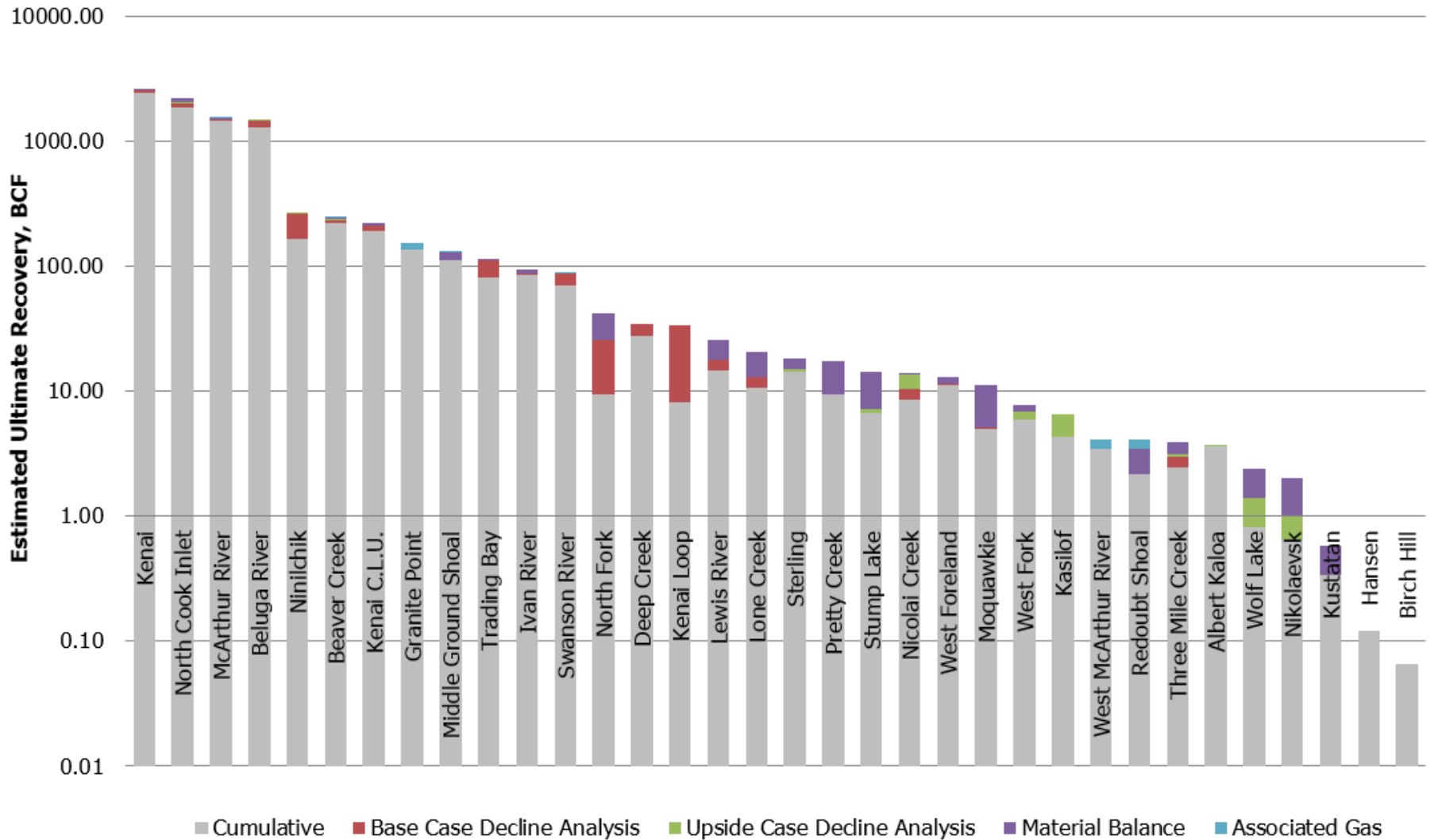
WELL NAME:				Ryder Scott Reservoir Solutions 6.0 (Public) <i>(Protected)</i>					
FIELD: Lewis River									
COUNTY, STATE: Reservoir Engineer: Islin Munisteri, May 29, 2015									
RESERVOIR: Beluga (Undefined Gas) (alphanumeric)									
* Wichert-Aziz correction for contaminants, if any									
WELLHEAD TEMP, °F:	36.0	SOUR GAS	MOLE %	Print Options	Calc AGIP	Least Squares Mean Fit Results			
BOTTOMHOLE TEMP, °F:	111.0	N ₂	0.00			Y-Intercept, BHP/z		2,945	
WET GAS GRAVITY: ??	0.566	CO ₂	0.00	Hide Graph	Calc OGIP	Apparent GIP, MMCF		26,284	
TVD, FEET:	4,700	H ₂ S	0.00			OGIP, MMCF		25,944	
COND. CORR.? (Y/N):	N	Formation Properties		New Form	Calc EUR	EUR, MMCF		25,505	
Corrected* Tc, °R:	347.95	S _w (dec)	0.45			Recovery Factor		0.9831	
Corrected* Pc, Psia:	673.48	C _w , μsip	?? 3.00	BHP/z @ Abandonment (Adj)		50			
V _w /V _g , AcFt/AcFt:	0.00	C _f , μsip	?? 3.51						





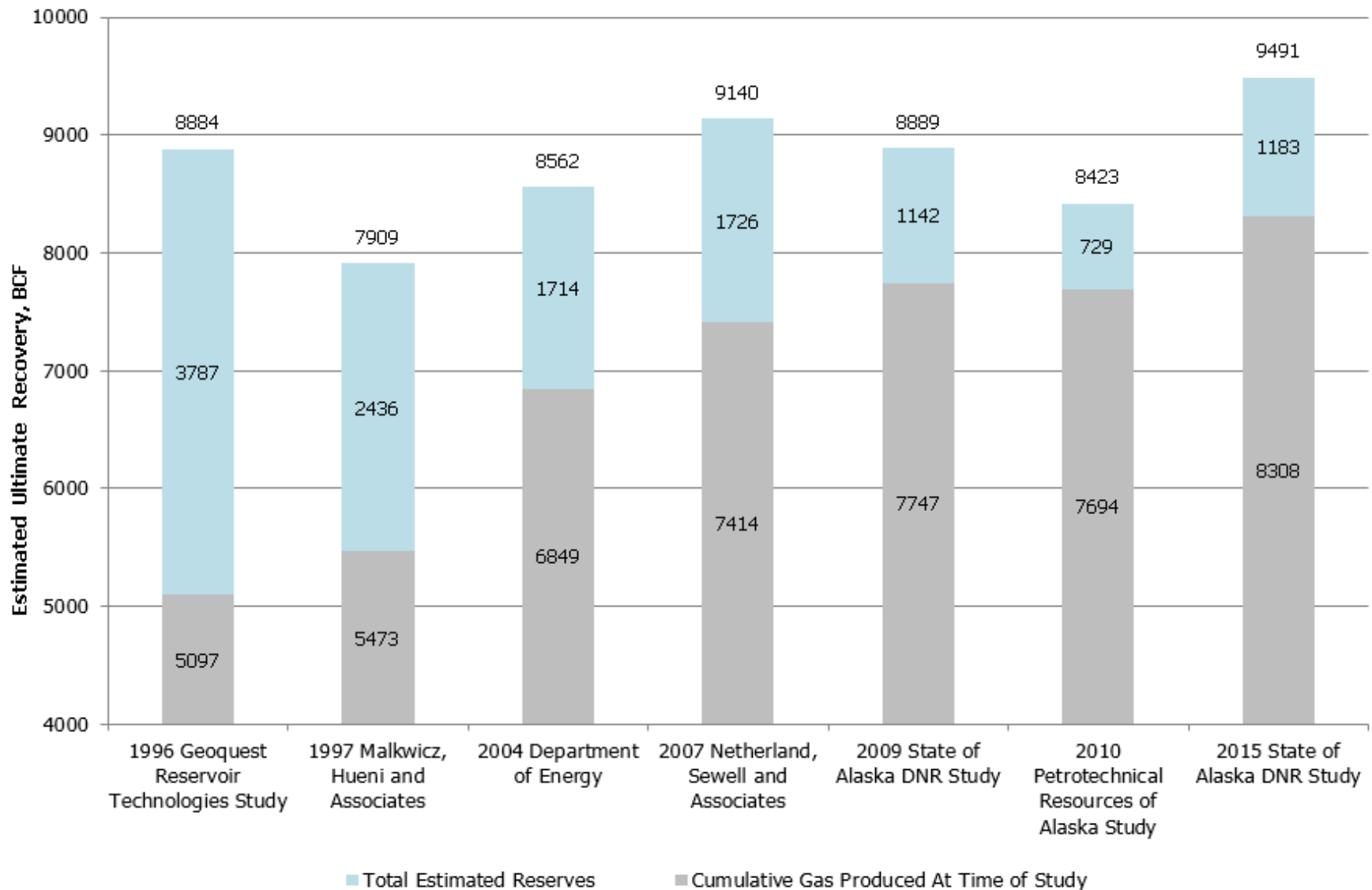
Remaining Reserves in the Cook Inlet Basin





Estimated Ultimate Recovery - Cook Inlet Fields

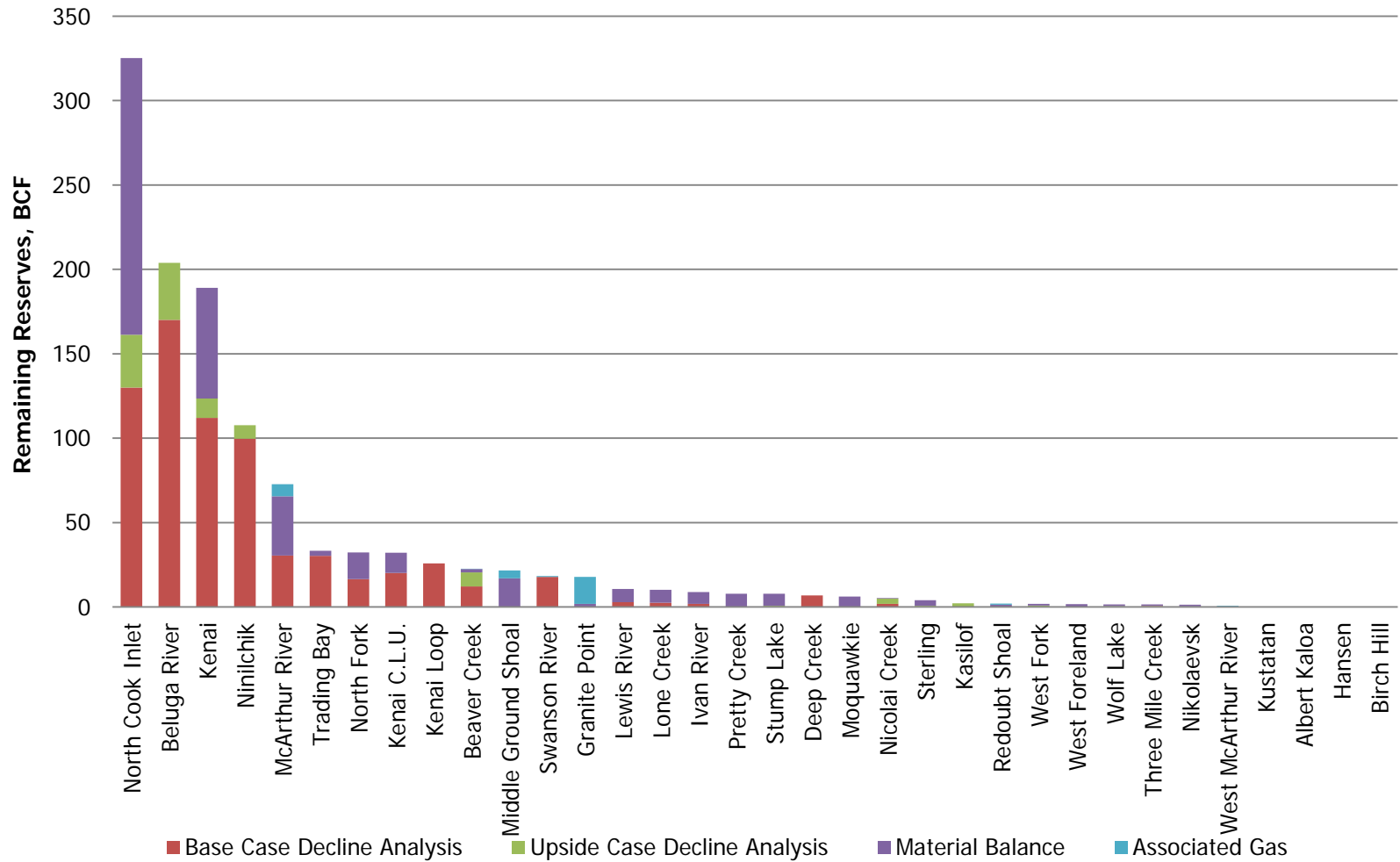




Comparison of Different Cook Inlet Natural Gas Studies

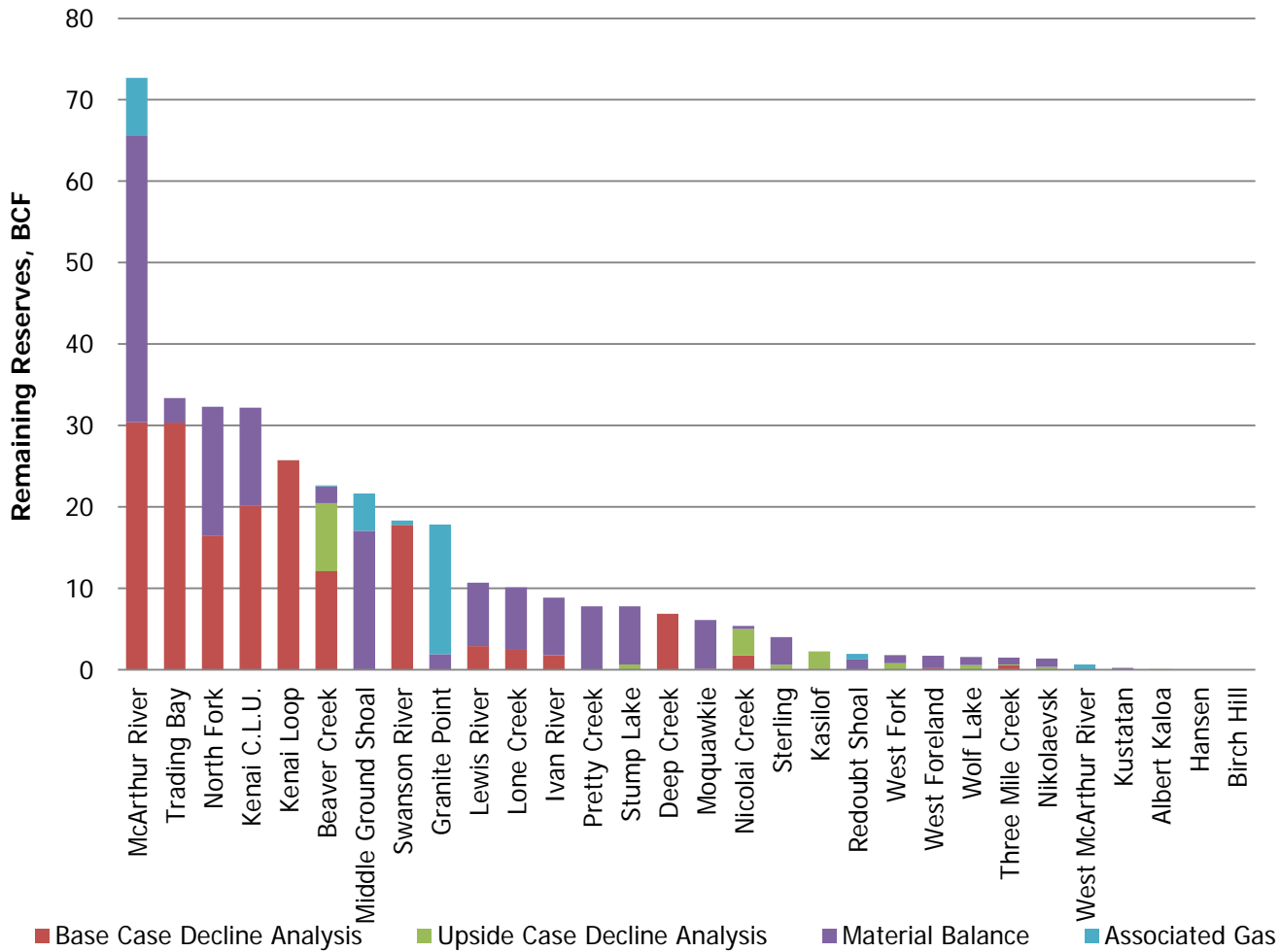
*2009 Study cumulative estimated from May 31, 2009 to December 31, 2009. Actual cumulative was 7,694 BCF.





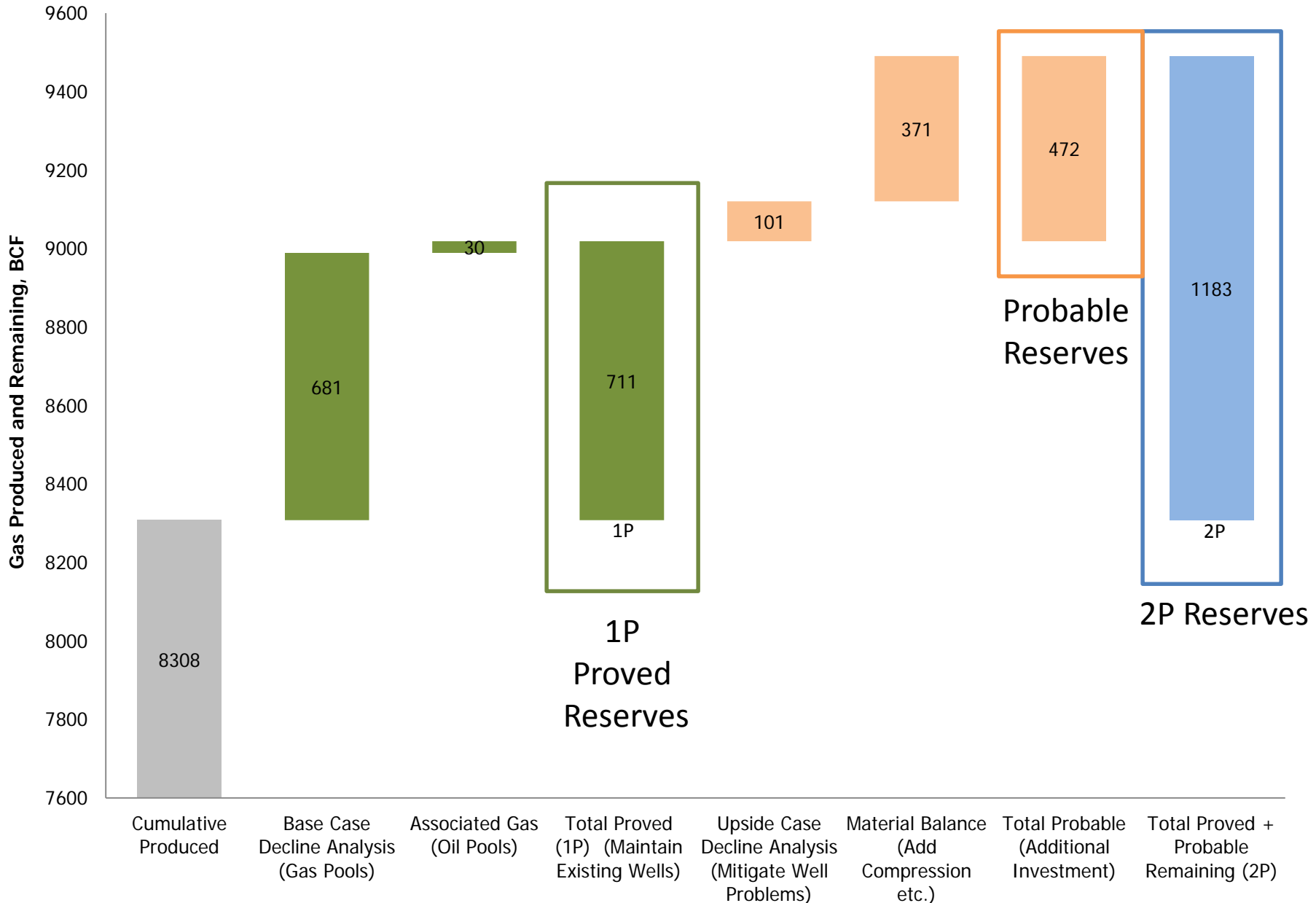
Remaining Reserves - All Cook Inlet Fields





Remaining Reserves - Cook Inlet Fields < 100 BCF Reserves





Remaining Reserves in the Cook Inlet Basin




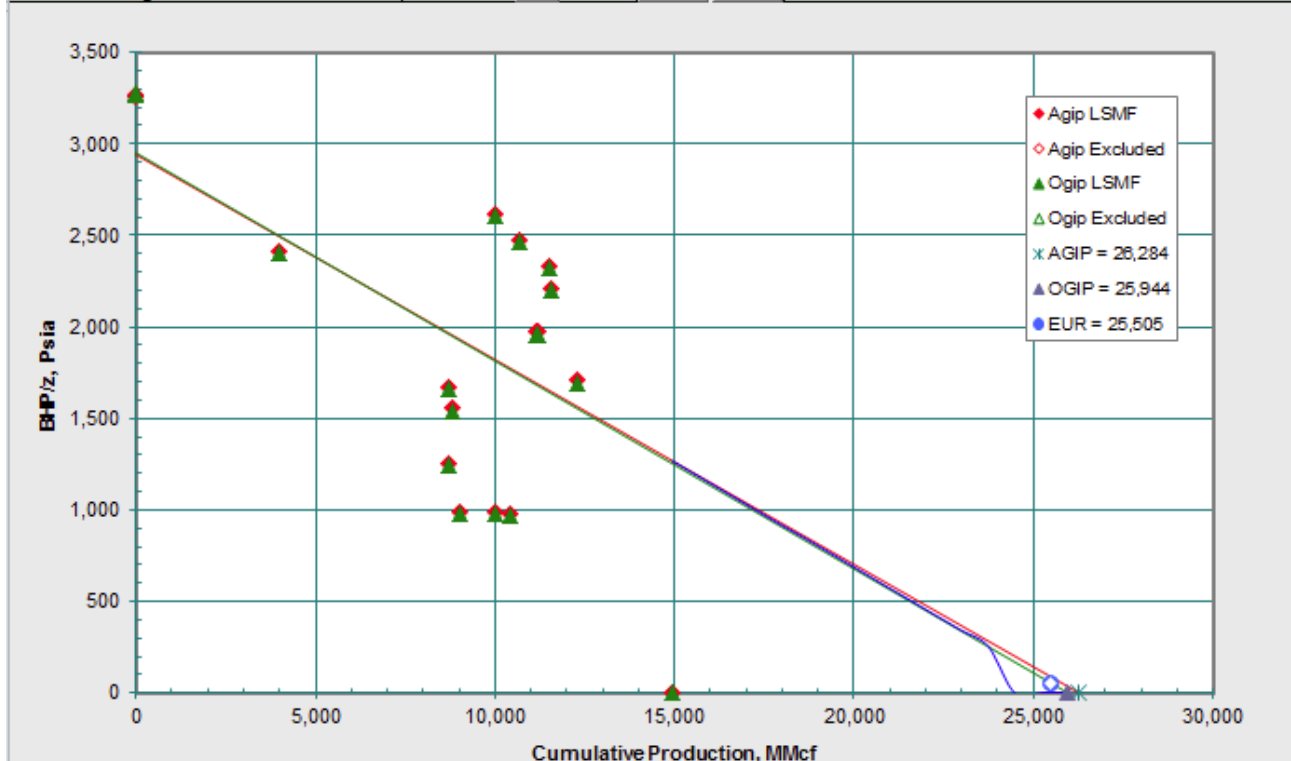
Thank you!

- John Burdick
- Jack Hartz (retired)
- Paul Decker
- Laura Gregersen
- Becca Hulme
- Family

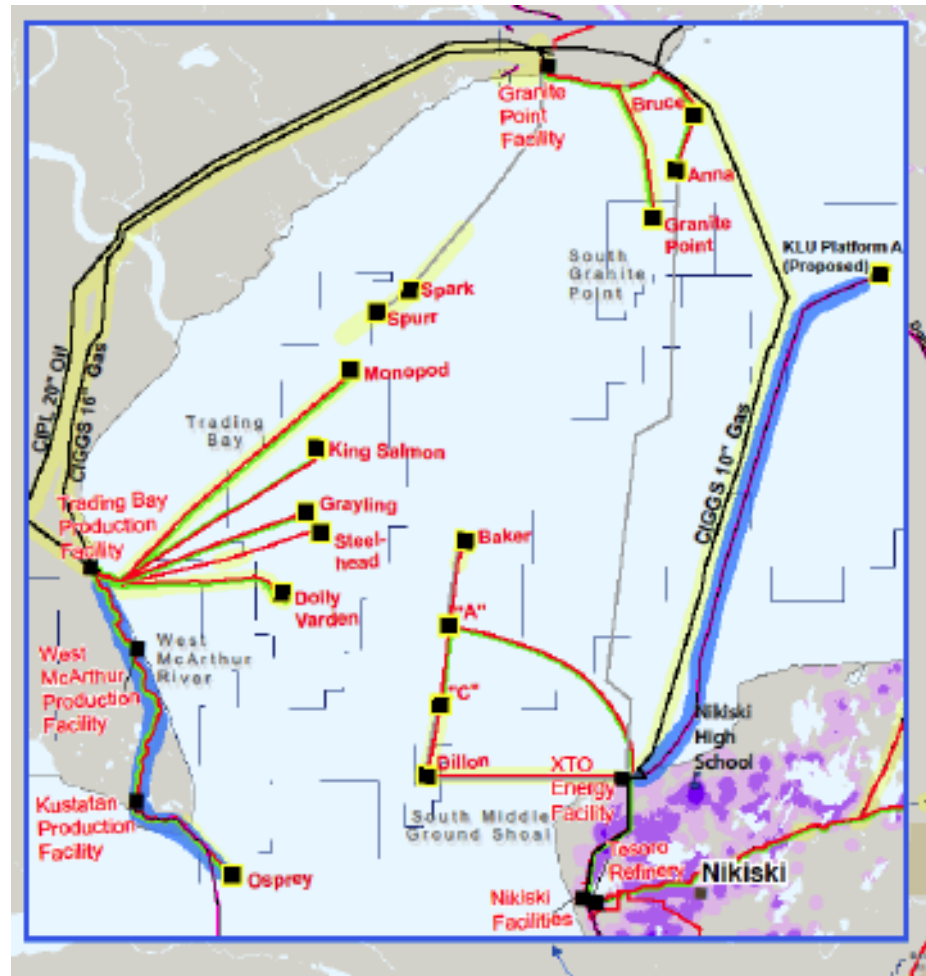


P/z

WELL NAME:				Ryder Scott Reservoir Solutions 6.0 (Public) (Protected)			
FIELD: Lewis River							
COUNTY, STATE: Reservoir Engineer: Islin Munisteri, May 29, 2015							
RESERVOIR: Beluga (Undefined Gas) (alphanumeric)							
* Wichert-Aziz correction for contaminants, if any							
WELLHEAD TEMP, °F:	36.0	SOUR GAS	MOLE %	Print Options	Calc AGIP	Least Squares Mean Fit Results Y-Intercept, BHP/z 2,945 Apparent GIP, MMCF 26,284 OGIP, MMCF 25,944	
BOTTOMHOLE TEMP, °F:	111.0	N ₂	0.00				
WET GAS GRAVITY: ??	0.566	CO ₂	0.00	Hide Graph	Calc OGIP	EUR, MMCF 25,505 Recovery Factor 0.9831 BHP/z @ Abandonment (Adj) 50	
TVD, FEET:	4,700	H ₂ S	0.00				
COND. CORR.? (Y/N):	N	Formation Properties		New Form	Calc EUR		
Corrected* Tc, °R:	347.95	S _w (dec)	0.45				
Corrected* Pc, Psia:	673.48	C _w , μsip	?? 3.00				
V_w/V_g, AcFt/AcFt:	0.00	C _f , μsip	?? 3.51				



Pipelines



Field	Cumulative Gas Produced, as of 12/31/2014, BCF	Base Case Decline Analysis (Gas Pools), BCF	Associated Gas (Oil Pools), BCF	Total Proved 1P Reserves, BCF	Upside Case Decline Analysis, BCF	Material Balance, BCF	Total Probable, BCF	Total Proved + Probable Remaining, 2P Reserves, BCF	Estimated Ultimate Recovery, BCF
Albert Kaloa	4	0	0	0	0	0	0	0	4
Beaver Creek	221	12	0	12	8	2	10	23	244
Beluga River	1298	170	0	170	34	0	34	204	1502
Birch Hill	0	0	0	0	0	0	0	0	0
Deep Creek	28	7	0	7	0	0	0	7	35
Granite Point	135	0	16	16	0	2	2	18	153
Hansen	0	0	0	0	0	0	0	0	0
Ivan River	85	2	0	2	0	7	7	9	94
Kasilof	4	0	0	0	2	0	2	2	7
Kenai	2435	112	0	112	11	66	77	189	2624
Kenai C.L.U.	191	20	0	20	0	12	12	32	224
Kenai Loop	8	26	0	26	0	0	0	26	34
Kustatan	0	0	0	0	0	0	0	0	1
Lewis River	15	3	0	3	0	8	8	11	26
Lone Creek	11	2	0	2	0	8	8	10	21
McArthur River	1476	30	7	38	0	35	35	73	1549
Middle Ground Shoal	111	0	5	5	0	17	17	22	133
Moquawkie	5	0	0	0	0	6	6	6	11
Nicolai Creek	9	2	0	2	3	0	4	5	14
Nikolaevsk	1	0	0	0	0	1	1	1	2
Ninilchik	164	100	0	100	8	0	8	108	271
North Cook Inlet	1889	130	0	130	31	164	195	325	2214
North Fork	9	17	0	17	0	16	16	32	42
Pretty Creek	10	0	0	0	0	8	8	8	17
Redoubt Shoal	2	0	1	1	0	1	1	2	4
Sterling	14	0	0	0	1	3	4	4	18
Stump Lake	7	0	0	0	1	7	8	8	14
Swanson River	70	18	1	18	0	0	0	18	89
Three Mile Creek	2	1	0	1	0	1	1	1	4
Trading Bay	82	30	0	30	0	3	3	33	115
West Foreland	11	0	0	0	0	2	2	2	13
West Fork	6	0	0	0	1	1	2	2	8
West McArthur River	3	0	1	1	0	0	0	1	4
Wolf Lake	1	0	0	0	1	1	2	2	2
Total	8308	681	30	711	101	371	472	1183	9491

Field	Oil Pool (AOGCC)	Solution GOR (SCF/STB)
Beaver Creek	Beaver Creek Oil	235
Granite Point*	Hemlock Undefined Oil	800
Granite Point*	Middle Kenai Oil	1110
McArthur River	Hemlock Oil	404
McArthur River	MidKenai G Oil	422
McArthur River	W Foreland Oil	271
Middle Ground Shoal	A Oil	1000
Middle Ground Shoal	B, C, D Oil	650
Middle Ground Shoal	E, F, G Oil	381
Redoubt Shoal	Undefined Oil	265
Swanson River	Hemlock Oil	175
Swanson River	Undefined Oil	175 (assumed from Hemlock Oil Pool)
Trading Bay	Mid Kenai G – NE Hemlock-NE Oil	275
Trading Bay	Hemlock Oil	318
Trading Bay	Mid Kenai B Oil	188
Trading Bay	Mid Kenai C Oil	370
Trading Bay	Mid Kenai D Oil	440
Trading Bay	Mid Kenai E Oil	563
Trading Bay	Undefined Oil	266
Trading Bay	W Foreland Oil	314
West McArthur River	Hemlock Undefined Oil	260
West McArthur River	W McArthur River Oil	235

Table 2-4. Assumptions for solution GOR used in the Cook Inlet basin, grouped by pool and field.



Platform	Oil Pool(s) (AOGCC)	Abandonment Rate (BOPD), Platform Basis	
		Actual	Assumption
Granite Point Field			
Anna	Hemlock Middle Kenai	300	300
Bruce	Hemlock Middle Kenai	300	300
Granite Point	Hemlock Middle Kenai	300	300
Middle Ground Shoal Field			
"A"	E Oil F Oil G Oil	300	300
"C"	E Oil F Oil G Oil	383*	300
Redoubt Shoal Field			
Osprey	Undefined Oil	300	300
Trading Bay Field			
Monopod	Hemlock	107*	50
Monopod	Mid Kenai B	50	50
Monopod	Mid Kenai C	71*	50
Monopod	Mid Kenai D	74*	50
Monopod	Mid Kenai	50	50
Monopod	Mid Kenai E	50	50
Monopod	Mid Kenai G – NE Hemlock-NE Oil	50	50
McArthur River Field			
Dolly Varden	Hemlock	150	150
Dolly Varden	Middle Kenai G	150	150
Grayling	Hemlock	162*	100
Grayling	Middle Kenai G	100	100
Grayling	West Foreland	150*	100
Steelhead	Hemlock	150	150
Steelhead	Middle Kenai G	150	150
King Salmon	Hemlock	150	150
King Salmon	Middle Kenai G	150	150

*Reached field abandonment time limit first



Field	Oil Pool (AOGCC)	Abandonment Rate (BOPD), Well Basis
Beaver Creek	Beaver Creek Oil	50
West McArthur River	W McAr Riv Oil	50
West McArthur River	Hemlock Oil	50
Swanson River	Hemlock	50

Table 2-2. Abandonment rate assumptions for oil pools producing to an onshore facility.

Platform	Gas Pool (AOGCC)	Abandonment Rate (MCFD), Pool Basis
Steelhead	Mid Kenai Gas	1200

Table 2-3. Abandonment rate assumptions for a non-associated gas pool in the McArthur River field producing to an offshore facility, forecasted on a pool level. The abandonment rate for the pool was calculated using 50 MCFD per well multiplied by 24 wells; hence the abandonment rate was 1,200 MCFD.



Gas Storage Pool (AOGCC)	Cumulative Storage Gas Injection, BCF	Cumulative Storage Gas Withdrawn, BCF	Gas Remaining in Storage, BCF
Kenai Cannery Loop Unit, Sterling C (CINGSA)	17.5	7.20	10.3
Kenai, Sterling 6 Gas Stor	32.0	12.2	19.8
Pretty Creek, Beluga	5.45	4.04	1.41
Swanson River 64-5 Tyonek	11.5	10.1	1.40
Swanson River 77-3 Tyonek	11.7	9.92	1.78

Table 3-3. Cumulative injection, withdrawal, and approximately 35 BCF storage balance for Cook Inlet gas storage reservoirs as of December 31, 2014.

