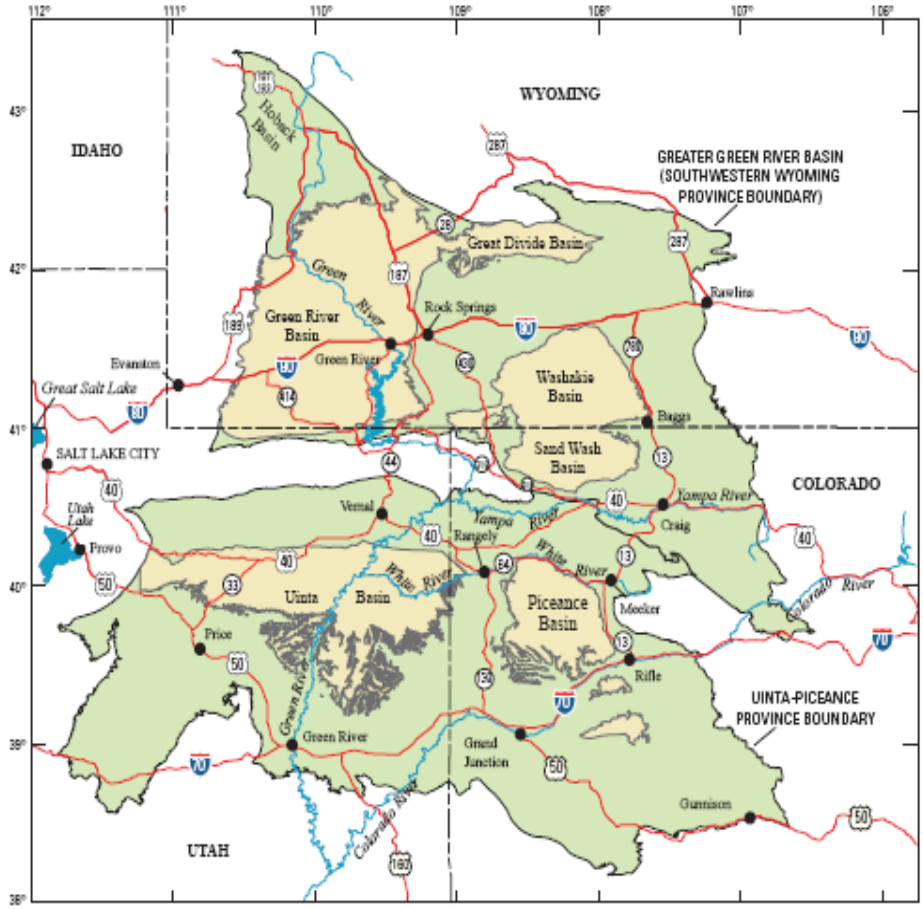
Applicability of a Hybrid Retorting Technology in the Green River Formation



Prepared by INTEK, Inc.

For the U.S. Department of Energy, Office of Petroleum Reserves
Naval Petroleum and Oil Shale Reserves

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Executive Summary

A broad range of new technologies is emerging, aimed at the efficient, economic, and sustainable production of fuels from oil shale resources. A number of these hybrid oil shale technologies are focus on development of near-surface oil shale resources. The purpose of this analysis is to identify the near-surface oil shale resource in the Green River Formation that is amenable to commercial development using such hybrid technology.

Three major basins in Colorado, Utah, and Wyoming were assessed in order to determine the areal extent and potential volumetric oil content of the oil shale resources applicable for a hybrid retorting technology with the following assumed screening criteria. The analysis also sought to determine how much of these resources underlay Federal, State, private, or locally owned lands. The screening criteria are:

- No more than 200 feet of overburden,
- Minimum pay thickness of 50 feet, and
- Minimum yield of 15 gallons per ton.

The starting point for this assessment was three assessments conducted by the United States Geological Survey (USGS) and made publicly available in 2011. Within the Green River Formation, four basins were evaluated for this study: the Greater Green River Formation and Washakie Basin located in Wyoming, the Uinta Basin located in Utah, and the Piceance Basin located in Colorado. In total, 29 candidate townships, collectively accounting for 107,520 acres, were identified as meeting the screening criteria. The candidates are described as "development tracts" with area ranging from 640 to 6,400 acres. These development tracts are blocks of land available for potential development. These tracts contain approximately 10.8 billion barrels of in-place resources. Table 1 provides a summary of the candidate resources in these 29 tracts by basin and land ownership. Table 2 provides the distribution of acreage in each ownership category.

Table 1: Summary of Applicable Resources

Basin	Development Tracts	Private (MM Bbls)	Federal (MM Bbls)	State (MM Bbls)	Tribal (MM Bbls)	Total (MM Bbls)
Green River Basin (WY)	4	135	135			270
Uinta Basin (UT)	22	1,908	5,681	1,301	365	9,254
Piceance Basin (CO)	3	294	1,026			1,320
Total - All Basins	**29**	**2,337**	**6,841**	**1,301**	**365**	**10,844**

The total target resource in the Greater Green River Basin is 270 million barrels, 9,254 million barrels in the Uinta Basin, and 1,320 million barrels in the Piceance Basin.

Table 2: Acreage Distribution for Development Tracts

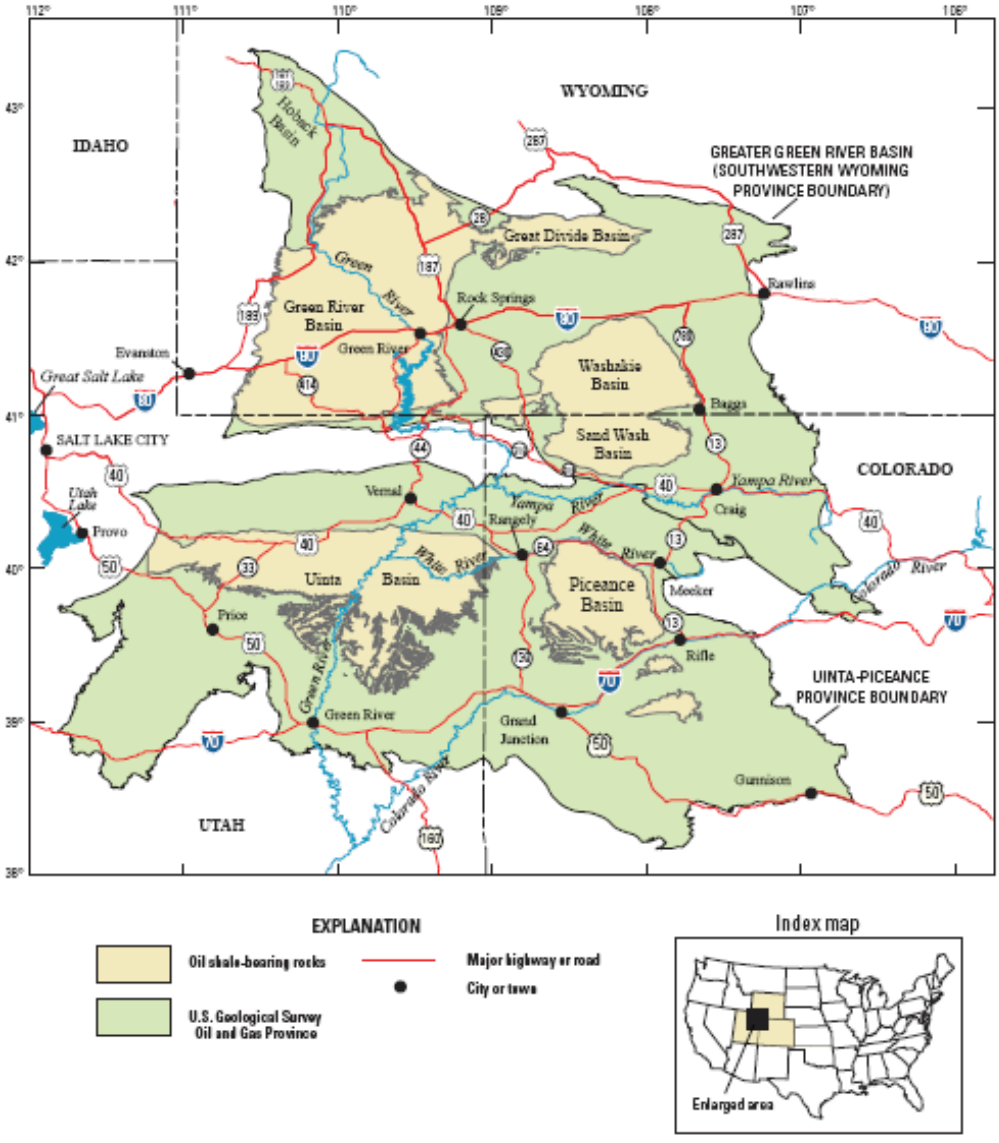
Basin	Development Tracts	Private (Acres)	Federal (Acres)	State (Acres)	Tribal (Acres)	Total (Acres)
Green River Basin (WY)	4	11,520	11,520			23,040
Uinta Basin (UT)	22	12,096	43,342	10,611	2,790	67,840
Piceance Basin (CO)	3	3,168	11,552			14,720
Total - All Basins	**29**	**26,784**	**66,694**	**10,611**	**2,790**	**107,520**

The total target area in the Greater Green River Basin is 23,040 acres, 67,840 acres in the Uinta Basin, and 14,720 acres in the Piceance Basin.

Introduction

The Greater Green River Formation, mapped in Figure 1, extends across sections of the states of Utah, Wyoming, and Colorado (Ref 1). This formation is the most highly concentrated oil shale deposit in the world and is also the most highly concentrated hydrocarbon deposit on the planet. The oil shale deposits are in three structural and sedimentary basins: the Piceance Basin in western Colorado, the Uinta Basin in eastern Utah and western Colorado, and the Greater Green River Basin in southwest Wyoming and northwest Colorado (Ref 2).

Figure 1: Extent of Uinta-Piceance and Greater Green River Structural and Sedimentary Basins



The United States Geological Survey (USGS) has conducted extensive assessments of the oil shale deposits and resources in each of these major basins. These assessments have recently been updated and detailed data sets, as well as summary analyses, have been made available for public use. They have estimated that the Piceance Basin contains about 1.5 trillion barrels of in-place oil resource, the

Uinta Basin contains about 1.3 trillion barrels, and the Green River Formation contains about 1.44 trillion barrels (Ref 2).

This assessment screens the Green River Formation, and the three structural basins in which it occurs, in order to determine the potential oil shale resource target using three criteria:

- Overburden: The depth of the formation, as measured from the surface to the top of the resource,
- Net Pay: The thickness of the shale bed beneath the overburden (net pay), and
- Richness: The estimated oil yield of the shale (richness).

The values used for these screening criteria will be provided in the following section. The screening criteria were applied to publicly available data used by USGS in their resource assessments.

The remainder of this document provides a description of the screening methodology, the location, ownership, and resource properties of the candidates identified within each basin, and a list of references and data sources used in this analysis. An appendix provides the raw data used for screening the resource.

Methodology

In conducting the study, the USGS assessment data was collected and evaluated for the Piceance Basin, the Uinta Basin, and the Greater Green River Basin (containing the Green River and Washakie Basins).

The USGS developed their resource assessment using core and assay data collected within the basins. Mapping and analytical techniques were used by the USGS to determine the resource at the "township" level and across the entire basin. For this effort, the USGS township level data was used.

As the USGS reports overburden at a "township" level as a single value, it is assumed to be uniform and flat across the township. This assumption was tested against the structural elevation maps for the zones. The maps show that the actual thickness of the overburden varies within a "township" by as much as a few hundred feet depending upon location in the basin. However, insufficient data is available to allow for a finer estimation of the overburden; then to the extent that the "townships" are not flat, the actual overburden may be different from the average data reported by the USGS.

The following criteria were used to screen the "townships":

- Overburden: Maximum depth of 200 feet.
- Net Pay: Minimum shale thickness of 50 feet.
- Richness: Minimum yield of 15 gallons per ton measured by Fischer Assay.

The townships which met all three criteria were determined to be candidates.

The township, with an area of up to 36 square miles (23,040 acres), is considered too large for a single project. In order to bring the size of the candidates into better alignment with the existing development tracts in the DOE National Strategic and Unconventional Resources Model, the townships were divided into quadrants and their properties were re-evaluated and subject to the screening criteria.

After the candidates were identified and located in the basins, the ownership of the resource was determined using maps and data collected from the Bureau of Land Management (BLM) in Utah, Colorado, and Wyoming. The maps show the portions of the resource which are on Federal lands, State lands, tribal lands, or private holdings.

A geographic information system (GIS) was developed to merge this data with township maps for each state. The combined maps were used to estimate the percentage of the resource in each ownership category.

In the remaining chapters of this report, the location of each candidate is illustrated and the values of their parameters are provided.

Location of Candidates Within the Green River Formation

Based on the methodology, maps were prepared showing the locations of each candidate which passed the screening criteria. Their locations are shown in Figures 2, 3, and 4, for the Uinta, Piceance, and Greater Green River Basins respectively.

Figure 2: Candidates in the Uinta Basin

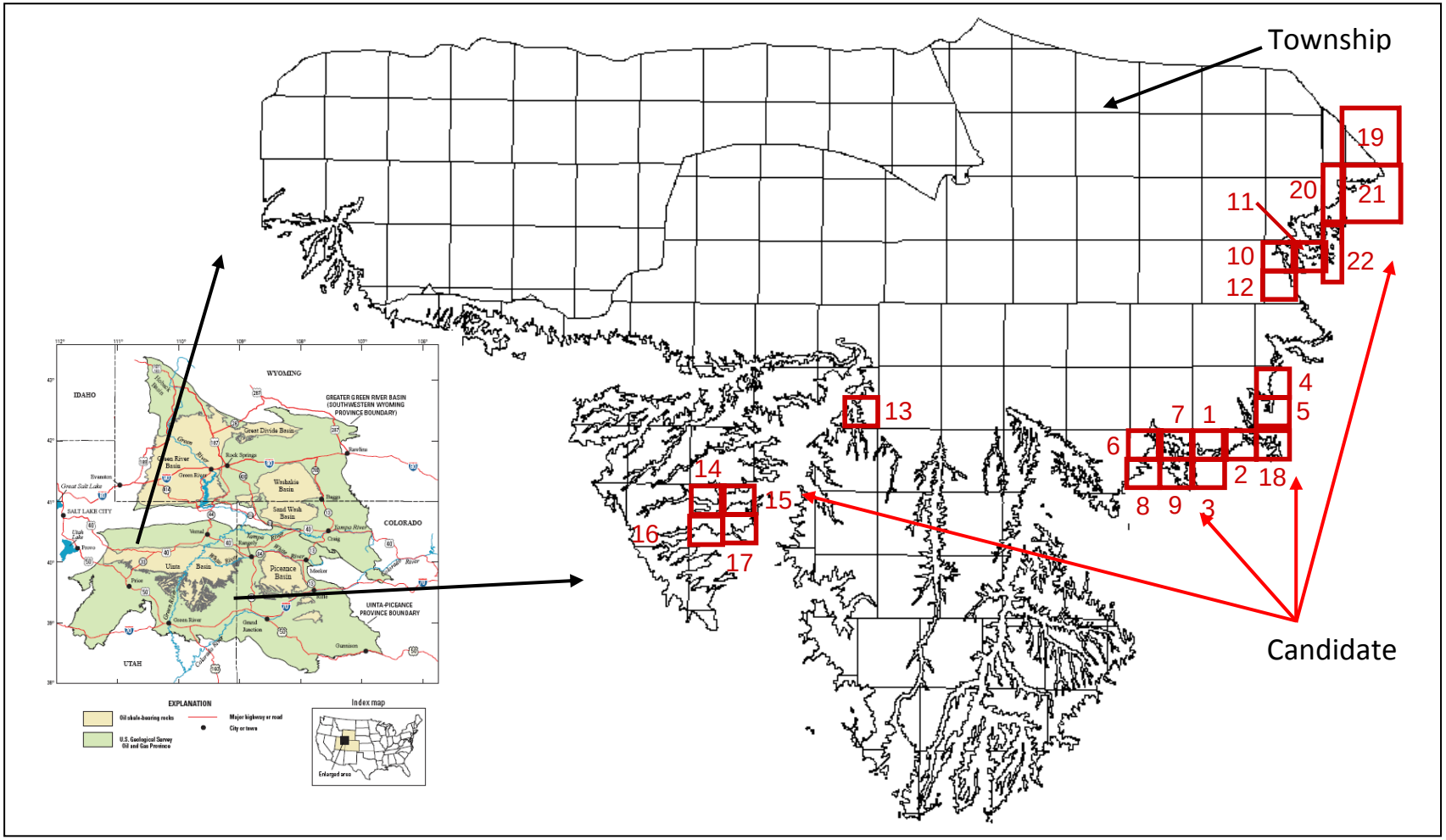


Figure 3: Candidates in the Piceance Basin

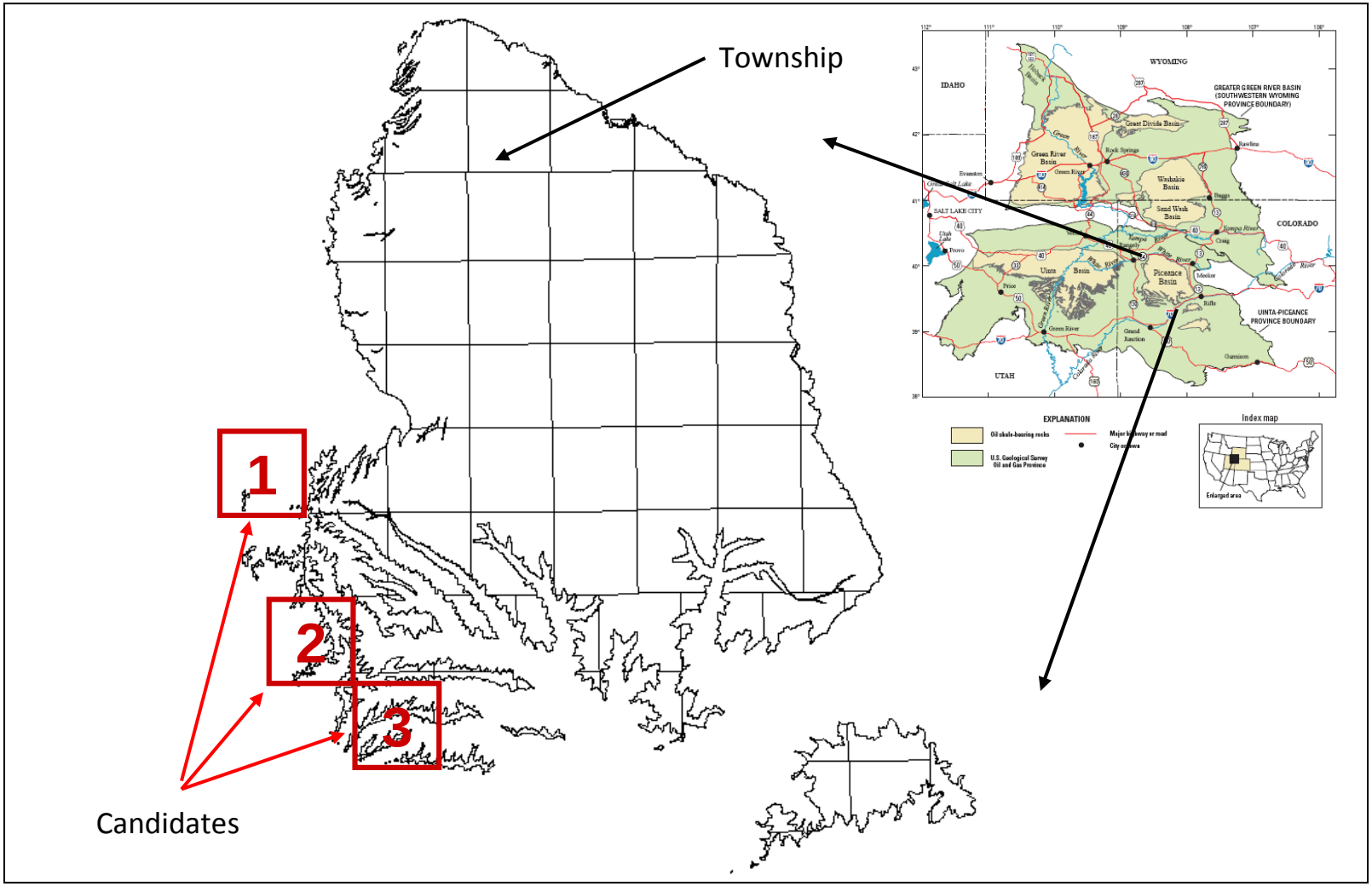
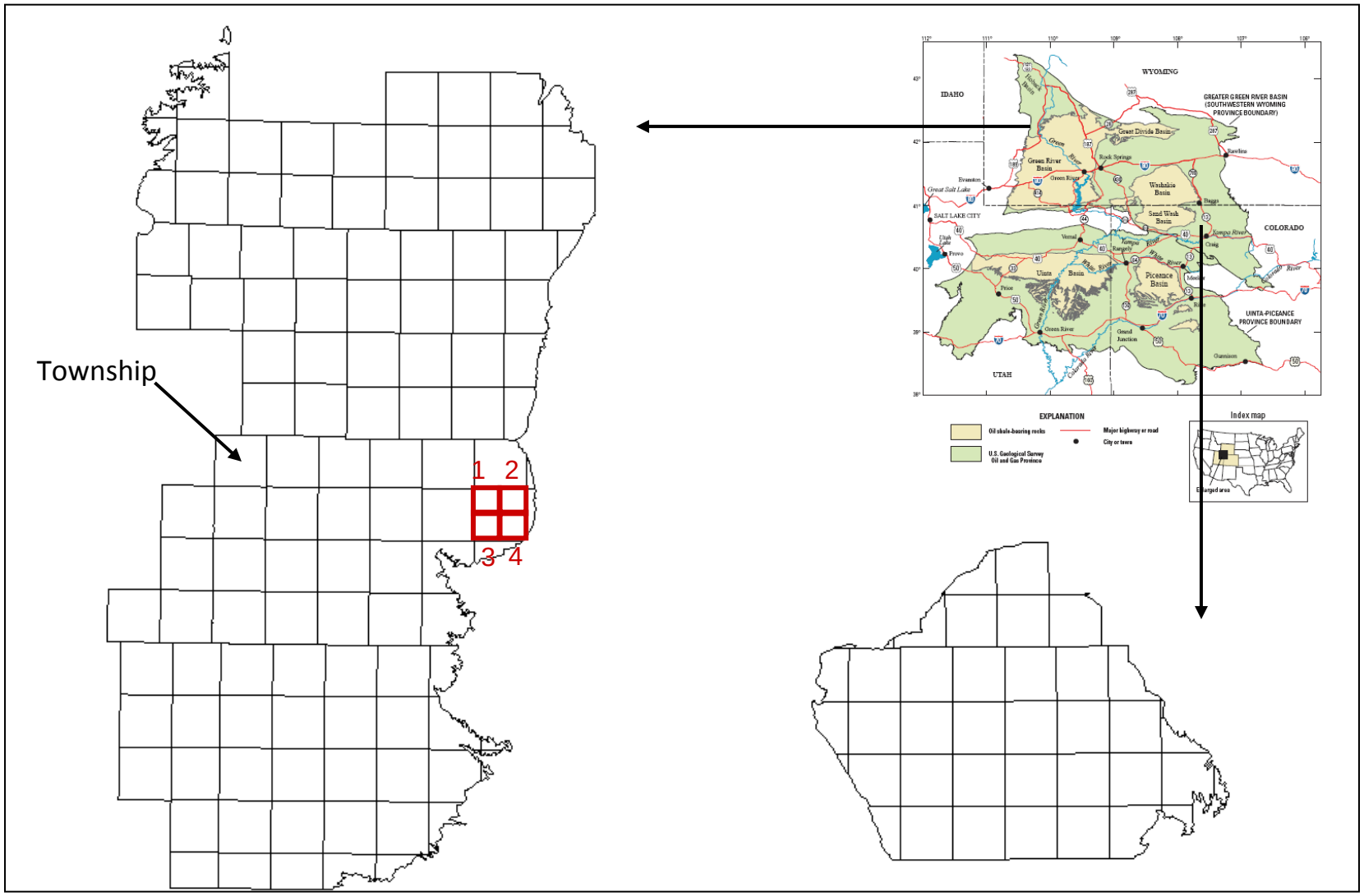


Figure 4: Candidates in the Greater Green River Basin (WY)



Uinta Basin (Utah)

The Uinta Basin is located primarily in the Vernal, Seep Ridge, Duchesne, Price, and Westwater Counties within Utah. Twenty two candidates within the Basin have been identified (Ref 3, 4, and 5) in Utah and western Colorado. The candidates are highlighted in Figure 2. The tract number corresponds with the numbers provided in the Figure.

Table 3: Average Properties for Uinta Basin Candidates

Township	"Tract" Number	Area (Acres)	Depth (Feet)	Thickness (Feet)	Yield (gallons/ton)	Resource (MMBbl)				
						Federal	Private	State	Tribal	Total
Candidates in Utah										
13S 24E	1	3,200	50	80	22	320	82	8	-	410
13S 24E	2	3,200	50	70	23	334	-	37	-	371
13S 24E	3	1,920	50	77	19	170	-	43	-	213
12S 25E	4	3,840	50	55	22	223	-	120	-	344
12S 25E	5	3,840	50	70	21	189	-	231	-	421
13S 23E	6	3,200	50	99	20	238	-	238	-	476
13S 23E	7	2,560	50	77	21	108	77	123	-	309
13S 23E	8	2,560	50	103	15	124	-	186	-	310
13S 23E	9	2,560	50	78	19	279	-	9	-	287
10S 25E	10	3,840	150	108	23	210	490	-	-	700
10S 25E	11	3,840	150	110	21	397	198	66	-	661
10S 25E	12	3,840	150	100	24	537	67	67	-	671
12S 18E	13	2,560	50	110	15	-	-	-	331	331
14S 16E	14	2,560	150	75	17	201	25	25	-	251
14S 16E	15	1,920	150	75	24	226	-	25	-	252
14S 16E	16	1,920	150	75	18	79	119	-	-	198
14S 16E	17	1,920	150	75	23	219	-	24	-	243
13S 25E	18	5,120	50	80	21	577	-	64	-	641
Candidates in Western Colorado										
2N 103W	19	2,560	50	125	15	196	113	34	34	376
1N 104W	20	3,840	50	125	20	541	180	-	-	721
1N 103W	21	3,840	50	120	15	460	81	-	-	542
1S 104W	22	3,200	50	120	18	53	475	-	-	528
Total		**67,840**				**5,681**	**1,908**	**1,301**	**365**	**9,254**

Table 3 provides the average properties based upon the USGS data and the resource distribution for each candidate. The total oil shale resource for the candidates is 9,254 million barrels.

Piceance Basin (Colorado)

The Piceance Basin is located primarily in the Rio Blanco, Garfield, and Mesa Counties within Colorado. Three candidates within the Basin have been identified (Ref. 3, 6, and 7). In Figure 3, the townships with candidate are marked by the red squares and labeled with the tract number found in the table below.

Table 4 provides the average properties, based upon the USGS data, for each candidate shown in Figure 3. The table provides the identification, the depth to the top of the layer, the thickness, the average yield, and the resource in place for each ownership category. As seen in the table, the total resource is 1,320 million barrels.

Table 4: Average Properties for Piceance Basin Candidates

Township	"Tract" Number	Area (Acres)	Depth (Feet)	Thickness (Feet)	Yield (gallons/ton)	Resource (MMBbl)				
						Federal	Private	State	Tribal	Total
4S 101W	1	1,920	50	60	17	128	23			151
6S 101W	2	6,400	200	60	18	449	79			528
7S 101W	3	6,400	200	64	21	449	192			641
Total		**14,720**				**1,026**	**294**			**1,320**

Greater Green River Basin (Wyoming)

The assessment of the Greater Green River Basin focused on two regions: the Green River Basin and the Washakie Basin. Both of these were limited to the sections located in Wyoming. Four tracts were identified within this basin (Ref 3, 8, and 9) and highlighted in Figure 4.

Table 5 provides average properties, based upon the USGS data, for the candidate. As seen in the table, the resource in the basin is 270 million barrels.

Table 5: Average Properties for the Greater Green River Basin (WY) Candidates

Township	"Tract" Number	Area (Acres)	Depth (Feet)	Thickness (Feet)	Yield (gallons/ton)	Resource (MMBbl)				
						Federal	Private	State	Tribal	Total
19N 106W	1	5,760	150	50	15	33.75	33.75			67.5
19N 106W	2	5,760	150	85	15	33.75	33.75			67.5
19N 106W	3	5,760	150	100	20	33.75	33.75			67.5
19N 106W	4	5,760	150	70	18	33.75	33.75			67.5
Total		**23,040**				**135**	**135**			**270**

Limitations of Analysis

The resource assessment presented here has important limitations that should be considered before using its results. These limitations include:

- The overburden is assumed to be uniform and flat across the township. Any variation in the overburden across the township is not captured by this assessment.
- The assessment was conducted using average properties and assumes that the borehole and assay data provide an accurate representation of the township and its subdivisions. Variations in thickness, depth, and yield are present and uncaptured at this level.
- The assessment was conducted using publicly available data from USGS assessments conducted of the three structures. It does not reflect other data from state geological surveys or private companies. Those sections, for which data was not available, such as the Sand Wash Basin and the Great Divide Basin, were not assessed.
- The assessment provides a technical estimate based upon the three screening criteria at the values specified in the methodology section. If they are varied, the results of the assessment may also differ.
- In addition, the assessment does not take into account infrastructure availability, project size and design, or project economics. As such, the resource estimates provide an estimated upper limit on recoverable kerogen.

None of the above limitations, however, invalidate the results in this analysis if they are viewed for what they are intended for, which is an estimate of the resource suitable for the three specified screening criteria.

References

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Appendix: Raw Data at Township Level

USGS Data downloads for Piceance Basin, Uinta Basin, and Green River Basin (Ref 3)

Basin	State	Township	Range	Overburden (ft)	Net Pay (ft)	Richness (GPT)
Uinta	Utah	T6S	R19E	150	125	9
Uinta	Utah	T6S	R20E	1,500	125	9
Uinta	Utah	T6S	R21E	700	125	9
Uinta	Utah	T3S	R9W	2,500	160	4
Uinta	Utah	T3S	R8W	3,500	175	4
Uinta	Utah	T3S	R7W	3,500	170	4
Uinta	Utah	T3S	R6W	4,000	140	4
Uinta	Utah	T3S	R5W	4,000	170	4
Uinta	Utah	T3S	R4W	3,500	170	4
Uinta	Utah	T3S	R3W	4,000	120	9.9
Uinta	Utah	T3S	R2W	4,000	75	9
Uinta	Utah	T3S	R1W	4,000	80	8
Uinta	Utah	T3S	R1E	4,000	110	9
Uinta	Utah	T3S	R2E	3,500	120	9
Uinta	Utah	T7S	R19E	700	125	9
Uinta	Utah	T7S	R20E	4,000	125	12
Uinta	Utah	T7S	R21E	4,000	130	13
Uinta	Utah	T7S	R22E	3,500	125	10
Uinta	Utah	T7S	R23E	3,500	125	9
Uinta	Utah	T7S	R24E	2,500	120	7
Uinta	Utah	T7S	R25E	1,500	120	4
Uinta	Utah	T4S	R9W	3,500	140	4
Uinta	Utah	T4S	R8W	2,500	150	6
Uinta	Utah	T4S	R7W	2,500	150	8.4
Uinta	Utah	T4S	R6W	2,500	130	5
Uinta	Utah	T4S	R5W	3,500	125	4
Uinta	Utah	T4S	R4W	3,500	115	5
Uinta	Utah	T4S	R3W	3,500	80	9
Uinta	Utah	T4S	R2W	2,500	75	9
Uinta	Utah	T4S	R1W	2,500	90	11
Uinta	Utah	T4S	R1E	3,500	90	11
Uinta	Utah	T4S	R2E	3,500	100	11
Uinta	Utah	T4S	R3E	700	125	15
Uinta	Utah	T8S	R20E	2,500	125	15
Uinta	Utah	T8S	R21E	3,500	155	16
Uinta	Utah	T8S	R22E	3,500	120	16
Uinta	Utah	T8S	R23E	3,500	105	15
Uinta	Utah	T8S	R24E	2,500	118	14

Appendix (Continued)

USGS Data downloads for Piceance Basin, Uinta Basin, and Green River Basin

Basin	State	Township	Range	Overburden (ft)	Net Pay (ft)	Richness (GPT)
Uinta	Utah	T8S	R25E	1,500	125	16
Uinta	Utah	T8S	R15E	300	100	9
Uinta	Utah	T8S	R16E	1,500	120	10.3
Uinta	Utah	T8S	R17E	1,500	100	15
Uinta	Utah	T8S	R18E	1,500	90	15
Uinta	Utah	T8S	R19E	1,800	90	15
Uinta	Utah	T5S	R1E	1,800	90	15
Uinta	Utah	T5S	R2E	700	90	15
Uinta	Utah	T6S	R3E	5,400	120	15
Uinta	Utah	T5S	R9W	1,500	125	6
Uinta	Utah	T5S	R8W	700	115	8
Uinta	Utah	T5S	R7W	1,500	125	9
Uinta	Utah	T5S	R6W	2,500	125	6
Uinta	Utah	T5S	R5W	2,500	150	6.5
Uinta	Utah	T5S	R4W	2,500	145	9
Uinta	Utah	T5S	R3W	1,500	120	10
Uinta	Utah	T9S	R15E	1,500	125	10
Uinta	Utah	T9S	R16E	2,500	100	11
Uinta	Utah	T9S	R17E	2,500	120	15
Uinta	Utah	T9S	R18E	2,500	95	15
Uinta	Utah	T5S	R19E	2,500	70	15.5
Uinta	Utah	T9S	R20E	2,500	120	17
Uinta	Utah	T9S	R21E	2,500	110	21
Uinta	Utah	T9S	R22E	2,500	120	20
Uinta	Utah	T9S	R23E	2,500	135	21
Uinta	Utah	T9S	R24E	1,500	130	21
Uinta	Utah	T9S	R25E	700	100	22
Uinta	Utah	T6S	R9W	50	110	9
Uinta	Utah	T6S	R8W	700	110	9
Uinta	Utah	T6S	R7W	1,500	120	6
Uinta	Utah	T6S	R6W	1,500	120	3.3
Uinta	Utah	T6S	R5W	2,500	160	7.5
Uinta	Utah	T6S	R4W	1,500	135	7.4
Uinta	Utah	T6S	R3W	700	170	9.5
Uinta	Utah	T10S	R14E	150	100	8
Uinta	Utah	T10S	R15E	1,500	125	8.3
Uinta	Utah	T10S	R16E	2,500	115	8
Uinta	Utah	T10S	R17E	1,500	110	10.5
Uinta	Utah	T10S	R18E	1,500	100	10.5
Uinta	Utah	T10S	R19E	1,500	78	15

Appendix (Continued)

USGS Data downloads for Piceance Basin, Uinta Basin, and Green River Basin

Basin	State	Township	Range	Overburden (ft)	Net Pay (ft)	Richness (GPT)
Uinta	Utah	T10S	R20E	1,500	85	18
Uinta	Utah	T10S	R21E	1,500	90	18
Uinta	Utah	T10S	R22E	1,500	100	22
Uinta	Utah	T10S	R23E	1,500	105	21
Uinta	Utah	T10S	R24E	700	107	23
Uinta	Utah	T10S	R25E	150	98	23
Uinta	Utah	T7S	R8W	50	110	9
Uinta	Utah	T7S	R7W	50	115	8
Uinta	Utah	T7S	R6W	300	125	4
Uinta	Utah	T7S	R5W	1,500	125	5
Uinta	Utah	T7S	R4W	1,500	125	8
Uinta	Utah	T11S	R10E	50	125	6
Uinta	Utah	T11S	R11E	50	125	6
Uinta	Utah	T11S	R12E	150	125	4
Uinta	Utah	T11S	R13E	300	115	8
Uinta	Utah	T11S	R14E	300	75	8
Uinta	Utah	T11S	R15E	700	100	8
Uinta	Utah	T11S	R16E	700	125	7.3
Uinta	Utah	T11S	R17E	700	110	9
Uinta	Utah	T11S	R18E	700	100	9
Uinta	Utah	T11S	R19E	1,500	75	12.5
Uinta	Utah	T11S	R20E	1,500	60	15
Uinta	Utah	T11S	R21E	1,500	70	13
Uinta	Utah	T11S	R22E	1,500	90	17
Uinta	Utah	T11S	R23E	1,500	75	19
Uinta	Utah	T11S	R24E	700	75	27
Uinta	Utah	T11S	R25E	300	76	24
Uinta	Utah	T12S	R14E	50	125	9
Uinta	Utah	T12S	R15E	50	125	9
Uinta	Utah	T12S	R16E	150	130	9
Uinta	Utah	T12S	R17E	150	125	9
Uinta	Utah	T12S	R18E	50	120	15
Uinta	Utah	T12S	R19E	700	115	13
Uinta	Utah	T12S	R20E	700	130	13
Uinta	Utah	T12S	R21E	700	100	14
Uinta	Utah	T12S	R22E	700	82	16
Uinta	Utah	T12S	R23E	700	80	21
Uinta	Utah	T12S	R24E	300	75	23
Uinta	Utah	T12S	R25E	50	70	21
Uinta	Utah	T13S	R14E	50	110	9

Appendix (Continued)

USGS Data downloads for Piceance Basin, Uinta Basin, and Green River Basin

Basin	State	Township	Range	Overburden (ft)	Net Pay (ft)	Richness (GPT)
Uinta	Utah	T13S	R15E	150	125	9.2
Uinta	Utah	T13S	R16E	150	105	13
Uinta	Utah	T13S	R17E	50	100	14
Uinta	Utah	T13S	R18E	300	60	19
Uinta	Utah	T13S	R19E	300	75	20
Uinta	Utah	T13S	R20E	300	130	10
Uinta	Utah	T13S	R21E	150	120	14
Uinta	Utah	T13S	R22E	300	103	15
Uinta	Utah	T13S	R23E	50	80	18
Uinta	Utah	T13S	R24E	50	80	22
Uinta	Utah	T13S	R25E	50	80	21
Uinta	Utah	T14S	R14E	50	75	11
Uinta	Utah	T14S	R15E	300	75	15
Uinta	Utah	T14S	R16E	150	75	18
Uinta	Utah	T14S	R17E	50	5	30
Uinta	Utah	T14S	R18E	700	10	29
Uinta	Utah	T14S	R19E	300	25	18
Uinta	Utah	T14S	R20E	300	150	14
Uinta	Utah	T14S	R21E	50	60	11
Uinta	Utah	T14S	R22E	50	100	12
Uinta	Utah	T15S	R15E	50	6	20
Uinta	Utah	T15S	R16E	50	25	21
Uinta	Utah	T15S	R17E	50	5	27
Uinta	Utah	T15S	R18E	700	5	29
Uinta	Utah	T15S	R19E	700	15	19
Uinta	Utah	T15S	R20E	300	60	19
Uinta	Utah	T15S	R21E	50	15	24
Uinta	Utah	T15S	R22E	50	8	10
Uinta	Utah	T16S	R16E	50	25	21
Uinta	Utah	T16S	R17E	50	5	25
Uinta	Utah	T16S	R18E	300	8	27
Uinta	Utah	T16S	R19E	700	7	22
Uinta	Utah	T16S	R20E	700	6	24
Uinta	Utah	T16S	R21E	150	6	26
Uinta	Utah	T16S	R22E	50	9	18
Uinta	Utah	T16S	R23E	50	8	15
Uinta	Utah	T17S	R18E	50	5	27
Uinta	Utah	T17S	R19E	300	5	22
Uinta	Utah	T17S	R20E	300	7	23
Uinta	Utah	T17S	R21E	300	8	24

Appendix (Continued)

USGS Data downloads for Piceance Basin, Uinta Basin, and Green River Basin

Basin	State	Township	Range	Overburden (ft)	Net Pay (ft)	Richness (GPT)
Uinta	Utah	T17S	R22E	50	6	20
Uinta	Utah	T18S	R19E	50	6	21
Uinta	Utah	T18S	R20E	50	5	19
Uinta	Utah	T18S	R21E	50	4	15
Uinta	Colorado	T2N	R104W	150	125	14
Uinta	Colorado	T2N	R103W	50	125	15
Uinta	Colorado	T1N	R104W	50	125	20
Uinta	Colorado	T1N	R103W	50	120	15
Uinta	Colorado	T1S	R104W	50	120	18
Uinta	Colorado	T2S	R104W	300	120	18
Piceance	Colorado	T2N	R97W	200	200	9
Piceance	Colorado	T2N	R98W	700	225	7
Piceance	Colorado	T2N	R99W	450	175	8
Piceance	Colorado	T1N	R96W	600	165	17
Piceance	Colorado	T1N	R97W	900	215	20
Piceance	Colorado	T1N	R98W	1,000	230	20
Piceance	Colorado	T1N	R99W	500	160	16
Piceance	Colorado	T1N	R100W	125	120	13
Piceance	Colorado	T1S	R95W	800	150	8
Piceance	Colorado	T1S	R96W	1,500	175	25
Piceance	Colorado	T1S	R97W	1,250	180	29
Piceance	Colorado	T1S	R98W	1,250	175	27
Piceance	Colorado	T1S	R99W	700	140	23
Piceance	Colorado	T1S	R100W	300	121	20
Piceance	Colorado	T2S	R95W	1,200	165	9
Piceance	Colorado	T2S	R96W	1,250	180	25
Piceance	Colorado	T2S	R97W	900	170	29
Piceance	Colorado	T2S	R98W	900	150	29
Piceance	Colorado	T2S	R99W	700	120	26
Piceance	Colorado	T2S	R100W	500	110	20
Piceance	Colorado	T3S	R94W	350	125	10
Piceance	Colorado	T3S	R95W	1,100	175	26
Piceance	Colorado	T3S	R96W	1,200	170	29
Piceance	Colorado	T3S	R97W	1,250	170	30
Piceance	Colorado	T3S	R98W	1,100	135	27
Piceance	Colorado	T3S	R99W	700	110	23
Piceance	Colorado	T3S	R100W	350	110	21
Piceance	Colorado	T4S	R94W	800	115	17
Piceance	Colorado	T4S	R95W	1,200	150	28
Piceance	Colorado	T4S	R96W	1,000	150	27

Appendix (Continued)

USGS Data downloads for Piceance Basin, Uinta Basin, and Green River Basin

Basin	State	Township	Range	Overburden (ft)	Net Pay (ft)	Richness (GPT)
Piceance	Colorado	T4S	R97W	800	120	28
Piceance	Colorado	T4S	R98W	700	105	26
Piceance	Colorado	T4S	R99W	700	95	24
Piceance	Colorado	T4S	R100W	300	80	18
Piceance	Colorado	T4S	R101W	50	60	17
Piceance	Colorado	T5S	R94W	700	120	25
Piceance	Colorado	T5S	R95W	800	130	27
Piceance	Colorado	T5S	R96W	700	125	26
Piceance	Colorado	T5S	R97W	800	107	26
Piceance	Colorado	T5S	R98W	800	95	25
Piceance	Colorado	T5S	R99W	700	90	23
Piceance	Colorado	T5S	R100W	300	70	19
Piceance	Colorado	T5S	R101W	150	69	11
Piceance	Colorado	T6S	R94W	700	90	22
Piceance	Colorado	T6S	R95W	650	110	26
Piceance	Colorado	T6S	R96W	700	105	27
Piceance	Colorado	T6S	R97W	700	103	24.5
Piceance	Colorado	T6S	R98W	700	96	25
Piceance	Colorado	T6S	R99W	750	70	20
Piceance	Colorado	T6S	R100W	350	60	19
Piceance	Colorado	T6S	R101W	200	60	18
Piceance	Colorado	T7S	R94W	800	76	13
Piceance	Colorado	T7S	R95W	650	70	19
Piceance	Colorado	T7S	R96W	500	90	24
Piceance	Colorado	T7S	R97W	700	90	24
Piceance	Colorado	T7S	R98W	250	80	18
Piceance	Colorado	T7S	R99W	250	70	23
Piceance	Colorado	T7S	R100W	200	64	21
Piceance	Colorado	T7S	R101W	250	60	18
Piceance	Colorado	T8S	R93W	750	75	13
Piceance	Colorado	T8S	R94W	900	75	17
Piceance	Colorado	T8S	R95W	1,000	72	20
Piceance	Colorado	T8S	R96W	400	60	20
Piceance	Colorado	T8S	R99W	250	60	20
Piceance	Colorado	T9S	R95W	250	70	19
Green River	Wyoming	T12N	R108W	44	170	13
Green River	Wyoming	T12N	R109W	308	170	11
Green River	Wyoming	T12N	R110W	616	150	9
Green River	Wyoming	T12N	R111W	851	120	5.7
Green River	Wyoming	T12N	R112W	909	113	4

Appendix (Continued)

USGS Data downloads for Piceance Basin, Uinta Basin, and Green River Basin

Basin	State	Township	Range	Overburden (ft)	Net Pay (ft)	Richness (GPT)
Green River	Wyoming	T13N	R107W	15	75	11
Green River	Wyoming	T13N	R108W	191	173	13
Green River	Wyoming	T13N	R109W	1,056	175	14.5
Green River	Wyoming	T13N	R110W	1,217	160	11
Green River	Wyoming	T13N	R111W	1,643	120	5.1
Green River	Wyoming	T13N	R112W	2,053	120	4.3
Green River	Wyoming	T14N	R106W	15	220	10.5
Green River	Wyoming	T14N	R107W	103	226	10.7
Green River	Wyoming	T14N	R108W	455	170	15
Green River	Wyoming	T14N	R109W	1,481	180	14.5
Green River	Wyoming	T14N	R110W	1,569	175	10.5
Green River	Wyoming	T14N	R111W	1,848	160	5.2
Green River	Wyoming	T14N	R112W	1,540	115	4.7
Green River	Wyoming	T14N	R113W	1,701	115	4.5
Green River	Wyoming	T15N	R106W	29	220	10.1
Green River	Wyoming	T15N	R107W	59	210	11.3
Green River	Wyoming	T15N	R108W	323	200	12.8
Green River	Wyoming	T15N	R109W	983	155	11.5
Green River	Wyoming	T15N	R110W	1,159	170	7
Green River	Wyoming	T15N	R111W	1,188	185	4.5
Green River	Wyoming	T15N	R112W	1,129	150	4.3
Green River	Wyoming	T15N	R113W	1,188	100	4
Green River	Wyoming	T16N	R107W	59	210	12
Green River	Wyoming	T16N	R108W	235	155	14
Green River	Wyoming	T16N	R109W	763	130	16
Green River	Wyoming	T16N	R110W	880	150	13
Green River	Wyoming	T16N	R111W	880	155	7
Green River	Wyoming	T16N	R112W	1,320	95	3
Green River	Wyoming	T16N	R113W	1,012	90	4
Green River	Wyoming	T17N	R107W	279	200	11
Green River	Wyoming	T17N	R108W	587	120	13
Green River	Wyoming	T17N	R109W	865	140	13
Green River	Wyoming	T17N	R110W	953	155	6
Green River	Wyoming	T17N	R111W	1,159	130	2
Green River	Wyoming	T17N	R112W	1,232	80	2.8
Green River	Wyoming	T17N	R113W	719	80	2
Green River	Wyoming	T18N	R106W	44	100	14
Green River	Wyoming	T18N	R107W	88	160	12.5
Green River	Wyoming	T18N	R108W	587	155	10
Green River	Wyoming	T18N	R109W	689	157	8.5

Appendix (Continued)

USGS Data downloads for Piceance Basin, Uinta Basin, and Green River Basin

Basin	State	Township	Range	Overburden (ft)	Net Pay (ft)	Richness (GPT)
Green River	Wyoming	T18N	R110W	865	160	7.5
Green River	Wyoming	T18N	R111W	939	140	2.1
Green River	Wyoming	T18N	R112W	836	110	1.9
Green River	Wyoming	T19N	R105W	29	145	9.3
Green River	Wyoming	T19N	R106W	150	80	17
Green River	Wyoming	T19N	R107W	235	135	13
Green River	Wyoming	T19N	R108W	381	170	8
Green River	Wyoming	T19N	R109W	631	110	8.1
Green River	Wyoming	T19N	R110W	733	80	7.3
Green River	Wyoming	T19N	R111W	763	75	6
Green River	Wyoming	T19N	R112W	675	60	1.5
Green River	Wyoming	T20N	R105W	44	115	8.7
Green River	Wyoming	T20N	R106W	572	120	15
Green River	Wyoming	T20N	R107W	557	160	10
Green River	Wyoming	T20N	R108W	440	200	3
Green River	Wyoming	T20N	R109W	513	95	5
Green River	Wyoming	T20N	R110W	792	75	7
Green River	Wyoming	T20N	R111W	748	30	8.2
Green River	Wyoming	T21N	R105W	147	60	13
Green River	Wyoming	T21N	R106W	499	80	14
Green River	Wyoming	T21N	R107W	719	85	8
Green River	Wyoming	T21N	R108W	704	65	5.5
Green River	Wyoming	T21N	R109W	660	30	8
Green River	Wyoming	T21N	R110W	880	40	8.5
Green River	Wyoming	T22N	R105W	161	80	9
Green River	Wyoming	T22N	R106W	557	75	15
Green River	Wyoming	T22N	R107W	689	70	14
Green River	Wyoming	T22N	R108W	631	60	9.5
Green River	Wyoming	T22N	R109W	601	50	9.9
Green River	Wyoming	T22N	R110W	689	55	9
Green River	Wyoming	T23N	R105W	293	65	10.5
Green River	Wyoming	T23N	R106W	455	57	13
Green River	Wyoming	T23N	R107W	469	90	12
Green River	Wyoming	T23N	R108W	396	95	11.5
Green River	Wyoming	T23N	R109W	425	70	8.1
Green River	Wyoming	T23N	R110W	513	40	9.9
Green River	Wyoming	T23N	R111W	455	25	7
Green River	Wyoming	T23N	R112W	323	30	4
Green River	Wyoming	T24N	R104W	73	50	5
Green River	Wyoming	T24N	R105W	381	50	7.8

Appendix (Continued)

USGS Data downloads for Piceance Basin, Uinta Basin, and Green River Basin

Basin	State	Township	Range	Overburden (ft)	Net Pay (ft)	Richness (GPT)
Green River	Wyoming	T24N	R106W	352	51	10
Green River	Wyoming	T24N	R107W	337	45	13
Green River	Wyoming	T24N	R108W	381	80	12.8
Green River	Wyoming	T24N	R109W	264	60	9.5
Green River	Wyoming	T24N	R110W	308	40	8.9
Green River	Wyoming	T24N	R111W	323	60	3.7
Green River	Wyoming	T24N	R112W	264	50	3
Green River	Wyoming	T25N	R104W	352	60	1
Green River	Wyoming	T25N	R105W	396	54	5
Green River	Wyoming	T25N	R106W	367	55	5
Green River	Wyoming	T25N	R107W	381	75	6.2
Green River	Wyoming	T25N	R108W	425	50	9
Green River	Wyoming	T25N	R109W	235	60	5
Green River	Wyoming	T25N	R110W	323	40	7.9
Green River	Wyoming	T25N	R111W	381	25	7
Green River	Wyoming	T25N	R112W	117	40	3.1
Green River	Wyoming	T26N	R104W	323	60	1
Green River	Wyoming	T26N	R105W	367	60	2
Green River	Wyoming	T26N	R106W	367	80	3
Green River	Wyoming	T26N	R107W	220	78	4
Green River	Wyoming	T26N	R108W	205	60	4.5
Green River	Wyoming	T26N	R109W	205	50	5
Green River	Wyoming	T26N	R110W	279	25	4
Green River	Wyoming	T26N	R111W	235	40	3.1
Green River	Wyoming	T26N	R112W	59	40	2.8
Green River	Wyoming	T27N	R104W	132	60	1
Green River	Wyoming	T27N	R105W	308	60	1.2
Green River	Wyoming	T27N	R106W	220	80	16
Green River	Wyoming	T27N	R107W	15	75	1.2
Green River	Wyoming	T27N	R111W	205	40	2
Green River	Wyoming	T27N	R112W	15	35	2
Green River	Wyoming	T28N	R111W	15	30	2
Washakie	Wyoming	T18N	R96W	484	125	4.3
Washakie	Wyoming	T18N	R97W	205	125	5.1
Washakie	Wyoming	T17N	R95W	851	400	6
Washakie	Wyoming	T17N	R96W	1,170	400	6
Washakie	Wyoming	T17N	R97W	681	340	5.1
Washakie	Wyoming	T17N	R98W	149	280	10.5
Washakie	Wyoming	T16N	R94W	251	300	5.5
Washakie	Wyoming	T16N	R95W	927	350	6.1

Appendix (Continued)

USGS Data downloads for Piceance Basin, Uinta Basin, and Green River Basin

Basin	State	Township	Range	Overburden (ft)	Net Pay (ft)	Richness (GPT)
Washakie	Wyoming	T16N	R96W	1,446	430	7.1
Washakie	Wyoming	T16N	R97W	1,633	410	8
Washakie	Wyoming	T16N	R98W	1,248	315	11
Washakie	Wyoming	T16N	R99W	739	300	14
Washakie	Wyoming	T16N	R100W	103	290	12
Washakie	Wyoming	T15N	R93W	22	440	6
Washakie	Wyoming	T15N	R94W	264	400	5.9
Washakie	Wyoming	T15N	R95W	722	450	7
Washakie	Wyoming	T15N	R96W	1,278	560	8
Washakie	Wyoming	T15N	R97W	1,915	550	9
Washakie	Wyoming	T15N	R98W	2,092	450	12
Washakie	Wyoming	T15N	R99W	1,524	325	15
Washakie	Wyoming	T15N	R100W	205	340	12
Washakie	Wyoming	T14N	R92W	10	430	6
Washakie	Wyoming	T14N	R93W	57	440	6
Washakie	Wyoming	T14N	R94W	120	445	7
Washakie	Wyoming	T14N	R95W	528	455	8
Washakie	Wyoming	T14N	R96W	1,092	625	9
Washakie	Wyoming	T14N	R97W	1,804	600	10.1
Washakie	Wyoming	T14N	R98W	1,930	560	10
Washakie	Wyoming	T14N	R99W	715	450	10
Washakie	Wyoming	T14N	R100W	8	400	11
Washakie	Wyoming	T13N	R92W	8	420	6
Washakie	Wyoming	T13N	R93W	8	425	6
Washakie	Wyoming	T13N	R94W	184	450	7
Washakie	Wyoming	T13N	R95W	630	460	7
Washakie	Wyoming	T13N	R96W	963	560	7
Washakie	Wyoming	T13N	R97W	1,316	570	8
Washakie	Wyoming	T13N	R98W	1,237	500	7
Washakie	Wyoming	T13N	R99W	297	455	6