



## **2011 MRWC Conservation Innovation Grant Project – Summary of Bioenergy Feasibility Testing - Keystone Materials Testing (KMT) and Hazen Research Inc.**

October 5, 2011

From: Scott Bockness, MRWC CIG Project Leader

### **Introduction**

In order to address the CIG bioenergy project objective (**Objective 2 –investigate and demonstrate the use of innovative bioenergy technologies that promote the utilization of invasive plant biomass as an untapped bioenergy source**) related to the feasibility of using saltcedar and Russian olive as potential biomass sources for bioenergy generation, feasibility testing has been conducted to establish some baseline bioenergy information. The baseline feasibility data can then be used for comparison to other plant feedstock materials, along with future samplings from the project management sites, to validate the potential of using invasive plant materials as a viable biomass source. Inquiries are being performed to identify bioenergy experts to provide technical guidance, data interpretation, and reporting on the feasibility aspects of the tested plant materials.

### **Product Testing Information/Summary**

Russian olive and saltcedar plant samples were collected from a variety of locations (5) in July and August of 2011 from locations in Wyoming and Montana. The locations that were utilized were within state/local project management areas from 2008-2010. The samples were sent to two independent laboratories to conduct standard bioenergy tests on the materials. The tests conducted by the laboratories were as follows: 1) caloric value (the BTU levels generated per pound of material); 2) ash % (the percentage of inorganic matter remaining after burning the material); 3) volatile matter % (the percentage of overall material exclusive of the moisture, that burns and generates gas and vapors from burning ); 4) moisture% (the percentage of water contained in the material –critical for wood pellet processing); carbon % (the percentage of solid residue, other than ash, remaining after combustion.

The following information is the compiled average test data results on the 4 samples of saltcedar plant material tested and the data from the 1 Russian olive sample tested:

#### **Saltcedar – 4 Locations**

Caloric Value (Dry) – 7,486 BTU's per pound of material burned  
Ash (Dry) – 2.63 %  
Volatile matter (Dry) – 83.76 %  
Moisture (as received) – 6.47 %  
Carbon (Dry) – 14.25

Note – A single set of feasibility tests was performed on saltcedar (and phragmites) in June of 2010. The BTU and ash test results of the saltcedar were consistent with the test results performed in 2011. The actual test report (KMT dated June 11, 2010) is attached for further review.

**Russian Olive (mulched) – 1 Location**

Caloric Value – 7,872 BTU's per pound of material burned

\*Ash (Dry) – 28%

\*Volatile matter (Dry) – 54%

Moisture (as received) – 13.97 %

Carbon (Dry) – 9.71 %

\*Due to inconsistencies of the ash/volatiles percentage levels identified in the Russian olive mulch material test results received from Hazen Research, an additional sample was retested. The test results in both cases were abnormally high levels of ash and therefore lower levels of corresponding volatiles. The test results may have been affected by the fact that the sample of material had been mulched prior to sample collection and high levels of debris may have contaminated the sample. Additional samples of Russian olive material will be tested to establish a reasonable level of thermal value data for the species of interest. The percentage of ash levels (inorganic matter) in a material sample corresponds directly to the percentage of the volatile matter (combustible matter) in the sample. In simple terms it is the percentage of combustible material versus the non-combustible material.

**Wood Fuels Feasibility Comparison Information**

In order to evaluate the preliminary bioenergy feasibility for Russian olive and saltcedar a review of known fuel characterization data for other species was performed. The heat value data used for comparison are heat value averages extracted from a report provided by the Montana Department of Natural Resources and Conservation. (Folk, 1-2)

<b>SPECIES</b>	<b>BTU</b>	<b>ASH%</b>	<b>Volatiles%</b>
Douglas Fir	9050	1.1	83.0
Ponderosa Pine	9028	1.7	79.9
White Pine	8900	0.1	78.0
W. Redcedar	9155	2.4	78.9
Grand Fir	8505	1.3	78.8
Lodgepole Pine	8800	0.5	73.5
Western Spruce	8740	3.8	69.6

*(Report Data provided from Richard Folk, Assistant Professor (Retired), Univ. of Idaho, College of Natural Resources)*

Russian olive	7,872	2.1	54.0
Saltcedar	7,486	2.3	83.7
Saltcedar 2010	7,424	2.4	82.7
Phragmites 2010	6,829	8.0	73.0

The fuel characteristics of wood materials will also vary within species due to a variety of factors such as: age, tree diameter, geographic location, and elevation. Additional elements in wood materials such as: carbon, hydrogen, nitrogen, and sulfur also need to be considered in attempting to analyze the heat values of wood materials. As stated earlier, additional testing of the Russian olive and saltcedar plant material will be performed to provide additional data that can be used to evaluate the feasibility of these wood products for bioenergy utilization.

### Herbicide Residue Test Information

In September of 2011, herbicide residue testing was performed on 2 separate saltcedar samples (Dolph – treated in 2008 / Blain – treated in 2009) by the Hazen Research laboratory. The samples were treated with triclopyr/basal oil mixtures at 25%/75% v/v applied with standard backpack sprayers. The herbicide residue tests conducted in 2010 are also shown below. The tests were performed in an attempt to identify existing herbicide residue levels and to provide some insight into herbicide decomposition rates within the plant material.

<b>SPECIES</b>	<b>Herbicide (Year Treated)</b>		<b>Residue Level (mg/kg)</b>
Saltcedar 2010	triclopyr	(2010)	210.00
Saltcedar 2010	triclopyr	(2009)	2.83
Saltcedar 2011	triclopyr	(2009)	.04
Saltcedar 2011	triclopyr	(2008)	.02

\*According to the scientific data related to the compound triclopyr, the thermal decomposition temperature for triclopyr is 290 degrees C (Celcius). Wood fires (fireplace/pellet stove) burn in the temperature range of 500-1000 degrees C. Burning herbicide treated materials under those conditions should result in greater than 95% thermal decomposition of the herbicide. Smoke emissions testing will be conducted at various intervals to identify specific levels of herbicide residue that may be detected from burning of the woody material.

The combustion of woody material is a complex process, whose end products are affected by factors such as fuel moisture, fuel chemistry, temperature, atmospheric gases, ignition source, and burning rate. Under normal fireplace and woodstove conditions, combustion products are vented into the outside atmosphere and only radiant heat enters the surrounding room. However, some gaseous and particulate materials can enter a room at low levels. The degree to which pesticides used in woody plants could be entrained with such material and how this type of pesticide exposure compares to standards set for occupational and ambient air is not known (P.B. Bush, *et al.*, 1987, 1-2).

Copies of the actual test reports are attached for review purposes, and additional inquiries regarding the CIG Project should be made to:

Scott Bockness, MRWC CIG Project leader at: [scott.bockness@montana.edu](mailto:scott.bockness@montana.edu); or by telephone at: 406.208.7657

## Reference

Folk, Richard, Univ. of Idaho, College of Natural Resources,  
"Wood Fuels Characterization" Report to Bitterroot R.C. & D Area, Inc.

Bush, P.B., Neary, D.G., McMahon, C.K., and Taylor, Jr., J.W.  
"Suitability of Hardwoods Treated with Phenoxy and Pyridine Herbicides for Use as  
Firewood." Arch. Environ. Contam. Toxicol. 16. 333-341 (1987)



## ANALYTICAL REPORT

August 16, 2011

Page 1 of 1

Work Order: 91H0014

Report To
Scott Bockness Center for Invasive Plant Management 2220 St. Johns Ave, Apt #24B Billings, MT 59102

Project: Bio-Mass

Project Number: Blain - Billings, MT

Analyte	Result	Method	Limits
ID:Blain Sample - MT		Matrix:BioMass	Collected: 08/02/11 00:00
Ash	2.4 %	E1755	
Moisture	6.47 wt %	E1755	
Volatile Matter	76.96 wt %	E1755	
Calorific Value	7500 BTU/lb	ASTM D240	

End of Report

Keystone Materials Testing, Inc.

Jerry Dawson  
Laboratory Manager



## ANALYTICAL REPORT

August 16, 2011

Page 1 of 1

Work Order: 91H0013

Report To
Scott Bockness Center for Invasive Plant Management 2220 St. Johns Ave, Apt #24B Billings, MT 59102

Project : Bio-Mass

Project Number: Dolph - Billings, MT

Analyte	Result	Method	Limits
ID:Dolph Sample - MT		Matrix:BioMass	Collected: 08/02/11 00:00
Ash	3.3 %	E1755	
Moisture	6.96 wt %	E1755	
Volatile Matter	75.91 wt %	E1755	
Calorific Value	7444 BTU/lb	ASTM D240	

End of Report

Keystone Materials Testing, Inc.

Jerry Dawson  
Laboratory Manager



## ANALYTICAL REPORT

August 16, 2011

Page 1 of 1

Work Order: 91H0004

Report To
Scott Bockness Center for Invasive Plant Management 2220 St. Johns Ave, Apt #24B Billings, MT 59102

Project: Bio-Mass

Project Number: WY

Analyte	Result	Method	Limits
ID:Russian Olive Mulch		Matrix:BioMass	Collected: 07/27/11 00:00
Ash	2.5 %	E1755	
Moisture	6.69 wt %	E1755	
Volatile Matter	75.47 wt %	E1755	
Caloric Value	6318 BTU/lb	ASTM D240	

End of Report

Keystone Materials Testing, Inc.

Jerry Dawson  
Laboratory Manager



## ANALYTICAL REPORT

August 16, 2011

Page 1 of 1

Work Order: 91H0003

Report To
Scott Bockness Center for Invasive Plant Management 2220 St. Johns Ave, Apt #24B Billings, MT 59102

Project: Bio-Mass

Project Number: Chalupa - WY

Analyte	Result	Method	Limits
ID:Saltcedar - Oct 2010		Matrix:BioMass	Collected: 07/27/11 00:00
Ash	2.8 %	E1755	
Moisture	8.05 wt %	E1755	
Volatile Matter	73.63 wt %	E1755	
Calorific Value	7420 BTU/lb	ASTM D240	

End of Report

Keystone Materials Testing, Inc.

Jerry Dawson  
Laboratory Manager



## ANALYTICAL REPORT

August 16, 2011

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Work Order: 91H0002

**Report To**

Scott Bockness  
Center for Invasive Plant Management  
2220 St. Johns Ave, Apt #24B  
Billings, MT 59102

Project: Bio-Mass

Project Number: Bumgarner - WY

Analyte	Result	Method	Limits
ID:Saltcedar - Aug 2009		Matrix:BioMass	Collected: 07/27/11 00:00
Ash	2.0 %	E1755	
Moisture	6.47 wt %	E1755	
Volatile Matter	74.20 wt %	E1755	
Calorific Value	7581 BTU/lb	ASTM D240	

End of Report

Keystone Materials Testing, Inc.

Jerry Dawson  
Laboratory Manager



**Hazen Research, Inc.**

4601 Indiana Street  
Golden, CO 80403 USA  
Tel: (303) 278-4501  
Fax: (303) 278-1528

CIPM-Montana State University  
Scott Bockness  
2220 St Johns Avenue, Apt. 243  
Billings, MT 59102

DATE September 12, 2011  
PROJ # 002 DGX  
CTRL # G316/11  
REC'D 07/29/11

Control Number	Sample Identification	As Received Ash, %
G316/11.1	Mulch New Split Recheck	27.55

By



Gerard H. Cunningham  
Fuel Laboratory Manager

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KMT Labs  
600 E 17th St S  
Newton, IA 50208

## ANALYTICAL REPORT

June 11, 2010

Page 1 of 1

Work Order: 90E0016

Project : Missouri River Watershed Coalition

PO : 4W2809

**Report To**

Les Puglia  
Yankee Pellet Mills  
177 Elm Street  
Effingham, NH 03882

Analyte	Result	Method	Limits
ID:Tamarisk - Hot Springs			
		Matrix:BioMass	Collected: 04/01/10 00:00
Ash	2.1 %	E1755	
Moisture	5.0 %	E1755	
Triclopyr	210 mg/kg	GC/ECD	
Calorific Value	7319 BTU/lb	ASTM D240	
ID:Tamarisk - Edgemont			
		Matrix:BioMass	Collected: 04/01/10 00:00
Ash	2.6 %	E1755	
Moisture	5.0 %	E1755	
Triclopyr	2.83 mg/kg	GC/ECD	
Calorific Value	7530 BTU/lb	ASTM D240	
ID:Phragmites - Grand Island			
		Matrix:BioMass	Collected: 04/07/10 00:00
Ash	8.0 %	E1755	
Moisture	9.3 %	E1755	
Triclopyr	-0.0200 mg/kg	GC/ECD	
Calorific Value	6829 BTU/lb	ASTM D240	

End of Report

Keystone Materials Testing, Inc.

Jerry Dawson  
Laboratory Manager

Phone 641-792-8451

600 East 17th Street South  
Newton, IA 50208

Fax 641-792-7989

**Hazen Research, Inc.**

4801 Indiana Street  
 Golden, CO 80403 USA  
 Tel: (303) 279-4501  
 Fax: (303) 278-1626

Date August 19 2011  
 HRI Project 002-DGX  
 HRI Series No. H30/11-1  
 Date Rec'd. 08/05/11  
 Cust. P.O.#

CIPM-MSU Bozeman  
 Scott Bockness  
 2220 St. Johns Avenue, Apt. 24B  
 Billings, MT 59102

Sample Identification  
 Dolph - Billings MT  
 Saltcedar

Reporting Basis >	As Rec'd	Dry	Air Dry
<b>Proximate (%)</b>			
Moisture	8.40	0.00	2.42
Ash	2.99	3.26	3.18
Volatile	79.46	86.75	84.65
Fixed C	9.15	9.99	9.75
Total	100.00	100.00	100.00
Sulfur	0.582	0.635	0.620
Btu/lb (HHV)	7248	7913	7721
Btu/lb (LHV)			
MMF Btu/lb	7484	8198	
MAF Btu/lb		8179	
<b>Ultimate (%)</b>			
Moisture			
Carbon			
Hydrogen			
Nitrogen			
Sulfur			
Ash			
Oxygen*	_____	_____	_____
Total			
Chlorine**			
Air Dry Loss (%)		6.13	
Forms of Sulfur, as S. (%)			
Sulfate			
Pyritic			
Organic	_____	_____	
Total	0.58	0.64	
<b>Water Soluble Alkalies (%)</b>			
Na2O			
K2O			

Lb. Alkali Oxide/MM Btu= \_\_\_\_\_  
 Lb. Ash/MM Btu= 4.12  
 Lb. SO2/MM Btu= 1.61  
 Lb. Cl/MM Btu= \_\_\_\_\_  
 As Rec'd. Sp.Gr.= \_\_\_\_\_  
 Free Swelling Index= \_\_\_\_\_  
 F-Factor(dry), DSCF/MM Btu= \_\_\_\_\_

Report Prepared By:

  
 Gerard H. Cunningham  
 Fuels Laboratory Supervisor

\* Oxygen by Difference.  
 \*\* Not usually reported as part of the ultimate analysis.



**Hazen Research, Inc.**

4601 Indiana Street  
Golden, CO 80403 USA  
Tel: (303) 279-4501  
Fax: (303) 279-1528

Date August 18 2011  
HRI Project 002-DGX  
HRI Series No. G316/11-1  
Date Rec'd. 07/29/11  
Cust. P.O.#

CIPM - Montana State University  
Scott Rockness  
2220 St Johns Avenue, Apt. 248  
Billings, MT 59102

Sample Identification  
Mulch

Reporting Basis > As Rec'd Dry Air Dry

Proximate (%)

Moisture	17.24	0.00	2.17
Ash	29.31	35.42	34.65
Volatile	45.02	54.39	53.21
Fixed C	8.43	10.19	9.97
Total	100.00	100.00	100.00

Sulfur	0.050	0.060	0.059
Btu/lb (HHV)	4307	5205	5092
Btu/lb (LHV)			
MMF Btu/lb	6302	8428	
MAF Btu/lb		8059	

Ultimate (%)

Moisture		
Carbon		
Hydrogen		
Nitrogen		
Sulfur		
Ash		
Oxygen*	_____	_____
Total		

Chlorine\*\*

Air Dry Loss (%) 15.40  
Forms of Sulfur, as S (%)

Sulfate		
Pyritic		
Organic		
Total	0.05	0.06

Lb. Alkali Oxide/MM Btu=  
Lb. Ash/MM Btu= 68.05  
Lb. SO2/MM Btu= 0.23  
Lb. Cl/MM Btu=  
As Rec'd. Sp.Gr.=  
Free Swelling Index=  
F-Factor(dry).DSCF/MM Btu=

Water Soluble Alkalies (%)

Na2O  
K2O

Report Prepared By:

Gerard H. Cunningham  
Fuels Laboratory Supervisor

\* Oxygen by Difference.

\*\* Not usually reported as part of the ultimate analysis.

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## ANALYTICAL REPORT

September 28, 2011

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Work Order: 91I0008

<b>Report To</b>
Scott Bockness Center for Invasive Plant Management 2220 St. Johns Ave, Apt #24B Billings, MT 59102

Project: Bio-Mass

Project Number: Dolph - MT

Analyte	Result	Method	Limits
ID:Dolph - Aug 08		Matrix:BioMass	Collected: 07/01/08 00:00

Triclopyr	0.4 mg/kg	EPA 8151
Surrogate: 2,5-Dichl	43.9 %	24-140

### Notes and Definitions

QS-07 The spike recovery for this QC sample was below established acceptance limits.

End of Report

Keystone Materials Testing, Inc.

Jerry Dawson  
Laboratory Manager



### ANALYTICAL REPORT

September 28, 2011

Page 1 of 1

Work Order: 91I0007

<b>Report To</b>
Scott Bockness
Center for Invasive Plant Management
2220 St. Johns Ave, Apt #24B
Billings, MT 59102

Project : Bio-Mass  
Project Number: Blain - MT

Analyte	Result	Method	Limits
ID:Blain - Sept 09		Matrix:BioMass	Collected: 09/01/09 00:00

Triclopyr	-0.02 mg/kg	EPA 8151	
Surrogate: 2,5-Dichl	83.8 %	24-140	

#### Notes and Definitions

QS-07 The spike recovery for this QC sample was below established acceptance limits.

End of Report

Keystone Materials Testing, Inc.

Jerry Dawson  
Laboratory Manager