Performance of Recycled Asphalt Pavement in Gravel Roads

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ABSTRACT

As more Recycled Asphalt Pavement (RAP) becomes available to use in roadways, The Wyoming T2/LTAP Center and two Wyoming Counties investigated the use of RAP in gravel roads. The Wyoming DOT and the Mountain-Plains Consortium funded this study. The investigation explored the use RAP as a means of dust suppression on gravel roads while considering road serviceability.

Several test sections were constructed in two Wyoming Counties and were monitored for dust loss using the Colorado State University Dustometer. Surface distress evaluations of the test sections were performed following a technique developed by the U.S. Army Corps of Engineers in *Special Report 92-26: Unsurfaced Road Maintenance Management*. The data collected were summarized and statistically analyzed.

The performance of RAP sections was compared with the performance of gravel control sections. This comparison allowed for fundamental conclusions and recommendations to be made for RAP and its ability for dust abatement. It was found that RAP-incorporated gravel roads can reduce dust loss without adversely affecting the road's serviceability. Other counties and agencies can expand on this research to add another tool to their toolbox for dust control on gravel roads.

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1. INTRODUCTION

1.1 Background

With the influx of oil and gas drilling in the Rocky Mountain region, local jurisdictions are seeing substantial increases in traffic, particularly trucks, on their road networks. Often this results in increased maintenance costs that are out of reach of many local jurisdiction budgets.

Gravel loss, primarily in the form of dust, is a common problem on Wyoming's gravel roads. This loss both degrades the road surface and creates environmental problems. For both engineering and environmental reasons, it is in the best interests of the roads' owners and users to minimize dust loss and provide good road surfaces. As vehicles kick up dust that blows away, the gravel surfacing loses the binding effects of fine particles. Then, surface distresses such as washboards – rhythmic corrugations – develop on the road surface. When the loss of fine material makes the surface more permeable, more water is trapped on the surface, leading to more surface distresses.

As dust enters the air, it increases the risk of violating federal air quality standards. Dust is considered a particulate matter made up of particles that are 10 micrometers (microns) or less, denoted as PM-10. Figure 1.1 shows the national distribution of non-attainment areas for PM-10. Sheridan County, Wyoming, is one of these non-attainment areas. As more users travel Wyoming's gravel roads, the risk posed by fugitive dust will only increase unless steps are taken to reduce this air quality problem and the associated health problems.

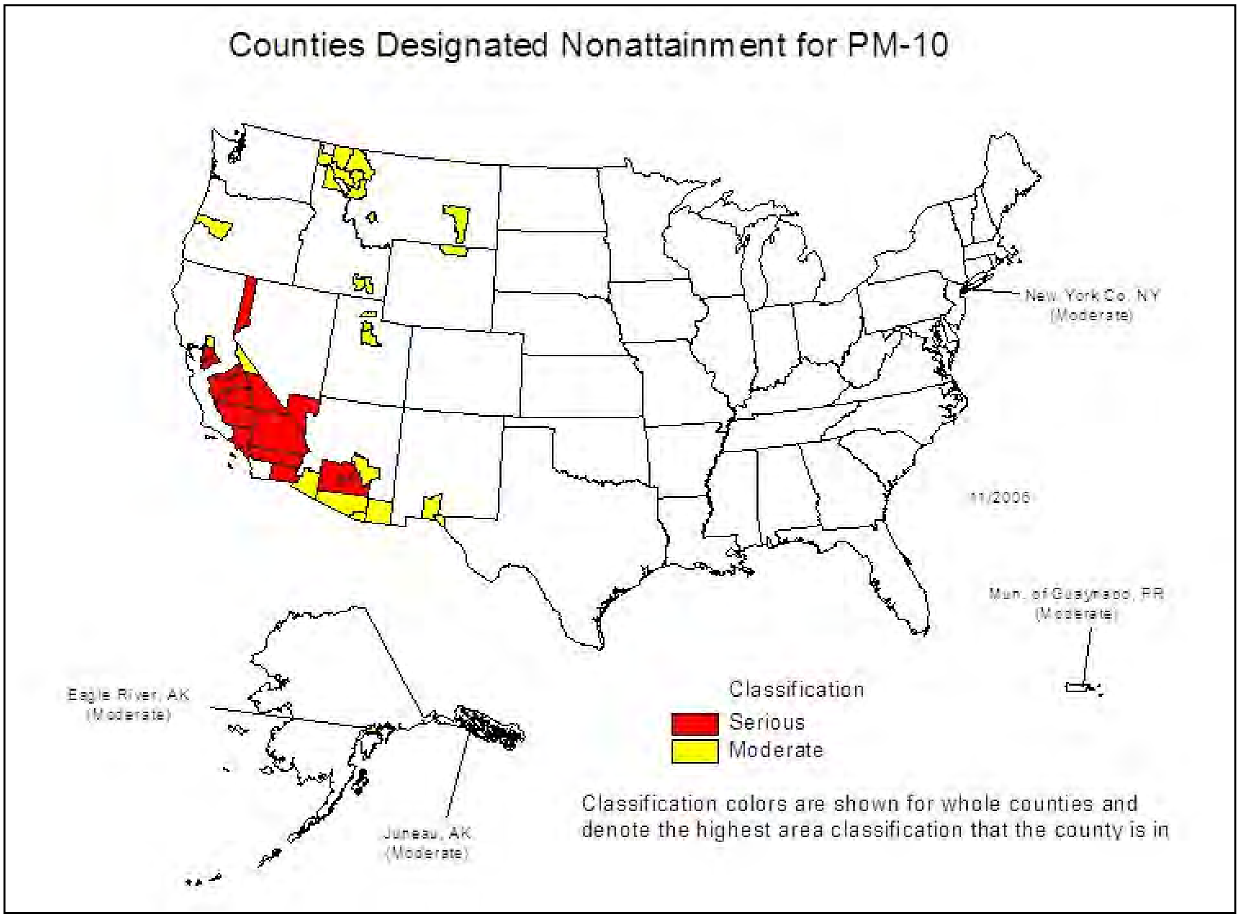

Figure 1.1 USEPA non-attainment areas for PM-10 particulate matter, November 2006.

Many unpaved county roads throughout Wyoming carry in excess of 500 vehicles per day (vpd), yet typical recommendations for when to pave an unpaved road range from 150 to 400 vpd. For financial reasons, many counties are unable to pave roads even though they know that in the long run paving is the most economical solution. Complicating the issue further is the knowledge that on many of these roads, traffic volumes will drop when drilling activities slow. Unfortunately, no one has a crystal ball that tells them just how much drilling activity will take place over the next decades. Considering these factors, it is important to know the most effective ways of managing unpaved roads, especially at higher traffic volumes.

1.2 Problem Statement

As the volume of traffic on unpaved roads in Wyoming increases with increased drilling activities, dust loss and surface distresses will continue to rise. It would make sense to pave some of these roads but many counties cannot afford these expensive operations, especially when the future volume on these roads is unknown. An alternative option needs to be explored that will reduce dust loss and associated surface distresses.

Recycled Asphalt Pavement (RAP) has been used as a surfacing additive on Wyoming's unpaved roads, streets, and alleys for several years. Recent state legislation compensates the Wyoming Department of Transportation (WYDOT) for RAP donated to Wyoming counties. WYDOT and local agencies need to evaluate the performance of blended RAP and virgin aggregate as a surfacing material for unpaved roads. Therefore, it is the intent of this research project to determine the feasibility of using RAP blends as surfacing material with a particular emphasis on its ability to reduce dust loss while maintaining road serviceability.

1.3 Research Objectives

The main objectives of this research project are as follows:

- Determine the effect of adding RAP to gravel roads in terms of reducing dust loss.
- Determine if the addition of RAP to gravel roads will maintain or improve roadway serviceability. That is, reduce surface distresses and not create any new distresses.
- Make recommendations to agencies who feel RAP-blended roadways would be beneficial to their operation.
- Make recommendations for further research into the use of RAP on gravel roads.

1.4 Report Organization

Section 2 of this report is a literature review of RAP, gravel roads, dust control, and the cost effectiveness of RAP utilization. Section 3 discusses the design of this experiment and explains the testing and data collection procedures used during the research project. Section 4 contains data collection from the field and laboratory evaluations. The raw data collected can be found in Appendix A through Appendix C. Section 5 contains the statistical analyses of the collected data. Finally, Section 6 summarizes the research project, presents conclusions, and offers recommendations to agencies and ideas for further research.

2. LITERATURE REVIEW

2.1 Introduction

Asphalt pavement is the most recycled product in America today (Davio 1999). As a result, recycled asphalt pavement (RAP) is being used more widely throughout the world in various applications. Most of the RAP is put back into the roadways of America as a base or surface material. RAP is also used in embankment and fill applications throughout the industry. Another possible use is to utilize RAP in gravel roads.

Gravel roads are abundant in America and especially in Wyoming. These roads are used by industry, farming, ranching, and tourism. The majority of problems that exist on gravel roads are the result of dust loss and the associated distresses. A possible additive to gravel roads is RAP. The addition of RAP may address dust loss and the associated problems. Whether used alone or in conjunction with other dust suppressants, RAP may provide an economical treatment for agencies fighting to keep dust loss at a minimum.

2.2 Recycled Asphalt Pavement

Reclaimed or recycled asphalt pavement (RAP) is the term given to removed and/or reprocessed pavement materials containing asphalt and aggregates. These materials are obtained when asphalt pavements are removed for reconstruction, resurfacing, or to gain access to buried utilities. When properly crushed and screened, RAP consists of high-quality, well-graded aggregates coated by asphalt cement (FHWA 1998).

2.2.1 Perspective on Recycling Asphalt

Highways are a leading recycler—with more asphalt pavement recycled than any other product in America. Few people realize that highways are among the nation's top recyclers. Around 80% of asphalt pavement is being reused in the highway environment. That is compared with only 28% of recycled post-consumer goods in the municipal solid waste stream. In the transportation field, recycling is a win-win proposition. RAP saves the taxpayers' dollars while maintaining high quality in the roadways of America. Recycling asphalt pavements also shows a healthy respect to the valuable materials used in asphalt pavements (AASHTO Center for Environmental Excellence 2003).

According to industry experts, the asphalt pavement industry is the nation's leader in recycling. Each year, 73 million tons of reclaimed asphalt pavements are reused. That is almost twice as much as paper, glass, plastic, and aluminum combined, which is saving taxpayers almost $300 million annually. The volume of recycled asphalt pavement is 13 times greater than recycling of newsprint, 27 times greater than recycling of glass bottles, 89 times greater than recycling of aluminum cans, and 267 times greater than recycling of plastic containers. Recycled asphalt is used not only for new roads, but also for roadbeds, shoulders and embankments (AASHTO Center for Environmental Excellence 2003).

Ownership of RAP can be broken down by contractor, agency, or a combination of the two. Wyoming's RAP is owned and controlled by an agency, most likely WYDOT. Colorado's RAP is owned by both agencies and contractors. The sources of RAP include pavement milling, asphalt pavement removal, and plant waste material. RAP can either be stockpiled in isolated single source piles or as a blend of multiple sources. RAP can be processed in a number of ways, including screening, crushing, or fractioning (combination of both screening and crushing). RAP can also be processed into fine aggregate, minus ½ inch, or into coarse aggregate, greater than one-half inch (Huber 2008).

Asphalt pavement recycling has many advantages, including:

- reduced cost of construction
- conservation of aggregate and binders
- preservation of existing pavement geometrics
- preservation of the environment
- conservation of energy

The use of hot-mix, hot in-place and cold in-place recycling achieves material and construction savings of up to 40, 50 and 67%, respectively. In addition, significant user-cost savings are realized due to reduced interruption in traffic flow when compared with conventional rehabilitation techniques (Davio 1999).

2.2.2 Obtaining RAP

Asphalt pavement is generally removed either by milling or full-depth removal. Milling involves the removal of the pavement surface using a milling machine, which can remove up to 2 inch (50 mm) thickness in a single pass. Full-depth removal involves ripping and breaking the pavement using a rhino horn on a bulldozer and/or pneumatic pavement breakers. In most instances, the broken material is picked up by front-end loaders and loaded into haul trucks. The material is then hauled to a central facility for processing. At this facility, the RAP is processed using a series of operations, including crushing, screening, conveying, and stacking (FHWA 1998).

Although the majority of old asphalt pavements are recycled at central processing plants, asphalt pavements may also be pulverized in place and incorporated into granular or stabilized base courses using a self-propelled pulverizing machine. Hot in-place and cold in-place recycling processes have evolved into continuous train operations that include partial depth removal of the pavement surface, mixing the reclaimed material with beneficiating additives (such as virgin aggregate, binder, and/or softening or rejuvenating agents to improve binder properties), and placing and compacting the resultant mix in a single pass (FHWA 1998).

2.2.3 Uses of RAP

The majority of the RAP produced is recycled and used, although not always in the same year it is produced. RAP is almost always returned back into the roadway structure in some form, usually incorporated into asphalt paving by means of hot or cold recycling, but it is also sometimes used as an aggregate in base or sub-base construction (FHWA 1998).

It has been estimated that as much as approximately 33 million metric tons (36 million tons), or 80 to 85% of the excess asphalt concrete presently generated, is reportedly being used as a portion of recycled hot mix asphalt, in cold mixes, or as aggregate in granular or stabilized base materials. Some of the RAP that is not recycled or used during the same construction season in which it is generated is stockpiled and is eventually reused (FHWA 1998).

Milled or crushed RAP can be used in a number of highway construction applications. These include its use as an aggregate substitute and asphalt cement supplement in recycled asphalt paving (hot mix or cold mix), as a granular base or sub-base, as a stabilized base aggregate; or as an embankment or fill material. Recycled asphalt pavement can be used as an aggregate substitute material, but in this application it also provides additional asphalt cement binder, thereby reducing the demand for asphalt cement in new or recycled asphalt mixes containing RAP. When used in asphalt paving applications (hot mix or cold mix), RAP can be processed at either a central processing facility or on the job site (in-place processing). The introduction of RAP into asphalt paving mixtures is accomplished by either hot or cold recycling (FHWA 1998).

Stockpiled RAP material can also be used as a granular fill or base for embankment or backfill construction. The use of RAP as an embankment base may be a practical alternative for material that has been stockpiled for a considerable time period, or may be a mixture from several different project sources. Use as an embankment base or fill material within the same right of way may also be a suitable alternative to the disposal of excess asphalt concrete that is generated on a particular highway project (FHWA, 1998).

According to FHWA, the majority of RAP is used in construction and maintenance applications, including:

- hot in-place recycling
- cold in-place recycling
- full-depth reclamation
- road base aggregate
- shoulder surfacing and widening
- various maintenance uses (Sullivan 1996).

The use of RAP as a maintenance tool in low-volume roads has not been investigated thoroughly and more research is needed in this field.

2.2.4 In-Place Recycling, Hot Mix Asphalt, Cold Mix Asphalt, Embankment, Fill, and MSE Walls

In-Place Recycling:

In-place recycling is an attractive method to rehabilitate deteriorated flexible pavements due to lower costs relative to new construction. It also supplies long-term societal benefits associated with sustainable construction methods. One approach is to pulverize and blend the existing hot-mix asphalt, base, and some of the subgrade to form a broadly graded granular material referred to as recycled pavement material (RPM). RPM can in turn be used in place as a base course for a new pavement. Blending is typically conducted to a depth of approximately 12 inches (300 mm). The RPM is compacted to form the new base course and is overlain with new hot-mix asphalt (HMA) (Li, Benson, Edil, and Hatipoglu 2007).

For cold in-place recycling, the pavement is removed by cold planing to a depth of 3 to 4 inches (75-100 mm). The material is then pulverized, sized, and mixed with an additive. Virgin aggregate may be added to modify RAP characteristics. An asphalt emulsion or a recycling agent is added. Once the gradation and asphalt content meet specifications, the material is placed and compacted. An additional layer is optional, such as a chip seal or 1 to 3 inches (75-100 mm) of hot-mix asphalt on top.

A 3-piece “train” may be used. This consists of a cold-planing machine, a screening and crushing unit, a mixing device, and conventional lay down and rolling equipment. This train occupies only one lane, thus maximizing traffic flow. Cost savings range from 20 to 40% more than conventional techniques. Since heat is not used, energy savings can be from 40 to 50% (Davio 1999).

For hot in-place recycling, the asphalt pavement is softened by heating, and is scarified or hot milled and mixed to a depth of ¾ to 1½ inches (18.75-37.5 mm). New hot-mix material (virgin aggregate and new binder) and/or a recycling agent is added in a single pass of a specialized machine in the train. A new wearing course may also be added with an additional pass after compaction (Davio 1999).

Hot-Mix Asphalt and RAP:

At a central processing plant, RAP is combined with new hot aggregate and asphalt to produce asphalt concrete, using a batch or drum plant. The RAP is usually obtained from a cold-planing machine, but could also be from a ripping or crushing operation (Davio 1999). The result is Hot-Mix Asphalt or HMA. The HMA is hauled from the plant to the project and compacted.

Cold-Mix Asphalt (Central Processing Facility):

RAP processing requirements for cold-mix recycling are similar to those for recycled hot mix. However, the graded RAP produced is incorporated into cold-mix asphalt paving mixtures as an aggregate substitute (Davio 1999). The mix is then hauled to the project site and compacted.

Full-Depth Reclamation:

In the full-depth reclamation process, all of the asphalt pavement section and a portion of the underlying materials are processed to produce a stabilized base course. The materials are crushed and additives are introduced. The materials are then shaped and compacted with the addition of a surface or wearing course that is applied on top (Davio 1999).

Embankment or Fill:

FHWA's "User Guidelines for Waste and By-product Materials in Pavement Construction" allows stockpiled RAP material to be used as a granular fill or base for embankment or backfill construction. RAP as an embankment base may be a practical alternative for material stockpiled for a considerable time period or that is a mixture from several project sources (Davio, 1999) (FHWA 1998).

Research by the Florida Institute of Technology has found a new application for RAP material. RAP may be utilized as a stabilizing material for sub-base below rigid pavements which will lead to increase use of RAP. RAP can also be used in embankment construction (Cosentino, Kalajian, & Shieh 2003).

Mechanically Stabilized Earth Walls

Mechanically stabilized earth (MSE) walls have been used throughout the United States since the 1970s. The popularity of MSE systems is based on their low cost, aesthetic appeal, simple construction, and reliability. To ensure long-term integrity of MSE walls, select backfills consisting of predominantly granular soils have been used. However, with increasing environmental and sustainability concerns, interest in using recycled materials for MSE walls has grown. Some of the most commonly available recycled materials are crushed concrete (CC) and RAP, and these materials are being considered for use as backfill in MSE walls in Texas (Rathje, et al. 2006).

2.3 Gravel Roads

The definition of *gravel* by the South Dakota LTAP and the FHWA is "a mix of stone, sand, and fine-sized particles used as a subbase, base or surfacing on a road. In some regions, it may be defined as aggregate" (Skorseth and Selim 2005).

In the United States, 53% of all the roads are unpaved. That translates into over 1.6 million miles of unpaved roadways, most of which are gravel roads. In other nations throughout the world, unpaved roads, generally gravel, make up most of the road network. Gravel roads are considered to provide the lowest service to the user and are usually considered inferior to paved roads. But paving and maintaining a paved road where the volume traffic is low is not economically feasible. For the most part, gravel roads exist to provide access or service. They are used by farmers and ranchers to get their product in and out of their fields; by the timber industry to get equipment in and product out of the forests; and by the mining and oil industries to get to and from their sites with equipment and product. Gravel roads are also used to access remote areas like lakes or campgrounds as well as providing rural residents access to their homes. In many cases, gravel roads will not be paved due to the very low traffic volumes and/or not having the funds to adequately improve the subbase and base and then pave the road (Skorseth & Selim 2005).

Two basic principles can make or break a gravel road. The grading device(s) and the surface gravel are the most important elements in a well maintained or rehabilitated gravel road. The grader is used to properly shape to road to provide for adequate drainage of water. The volume and quality of the gravel aggregate is most likely more important to the roadway than the grader. For instance, corrugations or "washboarding" is more likely caused by the material itself and less likely by the grader, although this is generally perceived by the public in an opposite fashion (Skorseth & Selim 2005).

The change in the vehicles and equipment using low volume gravel roads is another matter of importance. The size of trucks and agricultural equipment are increasing and the effect of the larger and heavier loads on gravel roads is just as serious as the effect on paved roads.

2.3.1 Distresses

There are seven types of distresses that can be characterized by a surface evaluation on a gravel road. The seven distresses are:

- Improper cross section
- Inadequate roadside drainage
- Corrugations
- Dust
- Potholes
- Ruts
- Loose aggregate

These distresses are established by the U.S. Army Corps of Engineers Cold Regions Research and Engineering Laboratory (Eaton and Beaucham 1992).

Another methodology that involves the same distresses in a different fashion is the Gravel PASER Manual. PASER stands for Pavement Surface Evaluation and Rating. This publication by the Transportation Information Center at the University of Wisconsin-Madison assesses gravel roadway conditions based on five roadway conditions. These five conditions involve the same distress as the U.S. Army Corps of Engineers approach but group them differently. The five conditions include:

- **Crown**
  The height and condition of the crown, and an unrestricted slope of roadway from the center across the shoulders to the ditches
- **Drainage**
  The ability of roadside ditches and under-road culverts to carry water away from the road

- **Gravel Layer**
  Adequate thickness and quality of gravel to carry the traffic loads
- **Surface Deformation**
  Washboarding, potholes, ruts
- **Surface Defects**
  Dust and loose aggregate (Walker, Entine, and Kummer 2002)

In whatever methodology used to evaluate gravel roads, the underlying distresses are the keys to the chosen procedure. Either approach is considered viable and is in the choice of the agency maintaining the roadway. Both methodologies have their own individual rating system based on the distresses present in the roadway. In any case, it is the distresses that will convey the quality of the gravel road. Keep in mind, the surface conditions of gravel roads can literally change overnight by means of heavy precipitation and local traffic. The aforementioned distresses will be described in more detail in the following subsections.

2.3.1.1 Cross Section and Crown

The shape of the entire roadway must be understood in order to properly maintain gravel roads. To properly maintain these roads, three basic roadway characteristics must be understood: a crowned driving surface, a shoulder area that slopes away from the driving surface, and a ditch. Generally, these three items must be correct in the road's cross section or a gravel road will not perform well, even under very low traffic. The shape of the roadway is the responsibility of the agency and equipment operators who are in charge of the road. The shape of the road surface and shoulders is classified as routine maintenance.

The cross section of a gravel road is designed to drain all water away from the roadway. Gravel roads tend to rut in wet weather. In fact, standing water at any place in the cross section is one of the major reasons for surface distresses and the failure of a gravel road. The agency in charge of maintaining the road must do everything possible in their routine maintenance to take care of the roadway's shape or else extra equipment and manpower may be needed to rehabilitate the road, which generally is not in the budget. Also, a well maintained roadway shape will serve low volume traffic well, but when heavy loads are introduced, the roadway may fail due to weak subgrade strengths and low gravel depths (Skorseth and Selim 2005).

2.3.1.2 Drainage

Roadside ditches and culverts must be able to handle surface water flow. When water is ponding, it is the result of poor roadside drainage. Sitting water on the roadway will seep to the layers below and soften the road base. Ditches need to be wide and deep enough to accommodate all of the surface water. When ditches and culverts are not in good enough condition due to improper shape or maintenance, water will not be directed properly, resulting in ponding and water backup. The shape of the ditch may be affected by erosion and repairs may be necessary. Erosion control efforts may be needed to help maintain ditches. Also, buildups of debris in the ditches or culverts need to removed as part of routine maintenance. Any roadway material in the ditch may be placed back on the roadway or hauled away (Eaton and Beaucham 1992) (Walker, Entine, and Kummer 2002).

2.3.1.3 Gravel Layer

There is a need for an adequate layer of gravel based traffic loads. Traffic loads are carried in the gravel layer and distributed to the subsoils. The thickness of the gravel layer is dependent on the amount of heavy traffic and the stability of the soils below. Generally a minimum of 6 inches (150 mm) is required.

Layers used for heavier loads or poor subsoils can be as much as 10 inches (250 mm) or more. Not only does the volume of the gravel layer matter but the quality of the gravel being used. It is in the quality in which good, long term service will be prevalent. The use of the word quality in this context refers to the gradation and durability of the gravel. These are measured by hardness and soundness testing. In general, the proper gradation has a good mix of larger aggregate, sand-sized aggregate and fines. Gradation and quality of the gravel is based on agency specifications and can widely vary (Walker, Entine, & Kummer, 2002).

2.3.1.4 Surface Deformations

Surface deformations include corrugations, potholes, and ruts. Washboarding or corrugations are closely spaced ridges and valleys or ripples at fairly regular intervals. Corrugation is the result of traffic dislodging aggregate from the roadway surface. These ripples develop perpendicular to the traveled way. Where heavy traffic and loose aggregate are present, corrugations tend to occur. They also usually form on hills and curves, at intersections, where accelerating and decelerating by the traffic is present and around areas where the surface is soft or potholed. Soft subsoils and improper grading can also result in washboarding. When washboarding is severe, water can become trapped in the valleys and more problems can occur.

Potholes are bowl-shaped depressions that can develop in the gravel or on the surface. Potholes are created when traffic wears away small pieces of the surface or where soft spots are developing in the underlying layers. Pothole growth is accelerated when water collects in the hole. As a result of the sitting water, the roadway continues to get worse because of more material becoming loose and/or more soft spots in the subbase form. Small isolated potholes can be fixed by hand. Moderate and severe potholes need the use of a grader and more aggregate to be fixed.

Ruts are a surface depression that usually forms in the wheel path of the road. Rutting develops parallel to the road’s centerline and can occur anywhere along the width of the driven road surface. Some ruts may be caused by the dislodging of the surface gravel while others occur with the permanent deformation in any of the road layers or subgrade. Repeated vehicle passes over soft spots in the road results in rutting. Poor crown and drainage can weaken the underlying soils and help accelerate the formation of ruts. Significant rutting can destroy a road (Eaton and Beaucham 1992) (Walker, Entine, and Kummer 2002).

2.3.1.5 Surface Defects

Surface defects include dust and loose aggregate. When the road is dry, traffic can create dust. The wear and tear on the gravel roads by the traffic loads will eventually loosen the larger aggregate from the soil binder or the fines. These fines are then picked up by the traffic and become airborne. Dust can create poor visibility for trailing vehicles and is considered an air pollutant. It is important to the replace these fines to maintain the roadway. Most of the time fines can be reclaimed from the shoulder and re-mixed into the existing surface.

Loose aggregate is the result of the wear and tear on the roadway that causes the fines to be lost in the form of dust. When the fines are lost, loose aggregate develops on the surface and/or the shoulder. Generally, the action of the traffic will move the loose gravel to the center or edges of the roadway. Loose aggregate can also form where vehicles tend to turn around or stop. The loose aggregate on the road and the fines from the road’s edge may be able to be remixed by a grader to recreate a well graded gravel and be reused (Eaton and Beaucham 1992).

2.4 Dust Control

There are strong reasons to control dust from unpaved roads. The top problem associated with unpaved roads is fugitive dust created by traffic and the loss of fines. Dust is considered as a type of particulate matter air pollution. It can contaminate houses and barns, it settles on vegetation and can reduce visibility over long distances. Dust is usually kicked up into the air by vehicles or blown off the road by wind. Not only is dust present on gravel roads, it is also generated by road construction and is a given at quarries and gravel pits. Also, the more dust that leaves the road surface, the less road surface that will remain. When dust is blown away, aggregates in the road surface loosen which can lead to many types of distresses and costly maintenance or rehabilitation efforts for the road departments as well as higher road user costs in the form of vehicle maintenance (Kuennen 2006) (Addo, Sanders, and Chenard 2004).

Dust is considered a coarse particle (PM-10), that is, dust is made up of particles that are 10 micrometers (microns) or less. Another way look at it is dust particles are about one-seventh of the diameter of a human hair. The EPA has had national air quality standards for PM-10 since 1987. These standards consist of a 24-hour standard not to exceed 150 micrograms per cubic meter of air, and an average standard of 50 micrograms per cubic meter annually (Kuennen 2006).

Scientific studies have linked particulate matter pollution with significant health problems such as:

- Increased respiratory symptoms like irritation of airways, coughing, and difficulty breathing
- Decreased lung function
- Aggravated asthma
- Development of chronic bronchitis
- Irregular heartbeat
- Premature death of people with heart or lung disease

Coughing, wheezing and decreased lung function in healthy individuals can be caused by particle pollution (Kuennen 2006).

The standards for dust exclude dust that occurs due to natural kick-up by the wind. It is not practical or feasible to place regulation on dust caused by the wind. On the other hand, it is possible to manage fugitive dust with dust control measures (Kuennen 2006).

2.4.1 Types of Dust Suppressants

Dust control methods range from spraying the road with chemicals to using geotextiles in the reconstruction of a road. Other efforts may include reduction in vehicular speed and the application of water. The use of dust suppressants is justifiable when traffic is low and paving is not a feasible option financially, the cost of the suppressants and application are low, and when stage construction is planned. The commonly used dust suppressants are water, chloride compounds, lignin derivatives, and resinous adhesives. Performance characteristics as well as the type and volume of traffic, climate, roadway conditions and product cost all play a significant role in selecting a dust suppressant (Addo, Sanders, and Chenard 2004) (Sanders and Addo 1993).

The main idea behind dust suppression is to keep moisture in the surface of the roadway. Moisture keeps the dust particles wet which in turn increases their mass and cohesion. The moisture allows fines in the gravel to adhere to other fines as well as other aggregate in the mix. When the moisture content is sufficient, optimum compaction under the traffic load is achieved (Kuennen 2006).

2.4.1.1 Water

Fresh water or sea water is the oldest dust suppressant used. It is readily available, although in the semi-arid West it is a commodity, and applied by spraying onto the road surface. The service capacity of water is limited and temporary due to evaporation. Excess watering may create undesirable runoff, being the cause for potential erosion and excessive mud. Several light applications of water are preferred over one heavy application. Although water may be less expensive as a product, the money saved will be consumed by the frequency of applications and labor costs (Addo, Sanders, and Chenard 2004) (Kuennen 2006).

2.4.1.2 Chloride Compounds

Road managers should consider chloride stabilization as a cost-effective method of dust control and other maintenance applications on gravel roads. Calcium chloride (CaCl) and magnesium chloride (MgCl) are the most commonly used chloride compounds. Sodium chloride (NaCl) is also sparingly used and is the least effective (Addo, Sanders, and Chenard 2004). These chlorides can be used by themselves or combined with other additives to create various types of product.

The desired effect of chloride compounds lies in their physical properties. Chlorides are hydroscopic, which means they can attract and absorb moisture from the atmosphere and retain it for extended periods of time. The result is a road surface that is constantly damp. The chloride properties are closely related to relative humidity and air temperature. A relative humidity of 30 to 40% is the point where calcium chloride and magnesium chloride stop attracting and absorbing moisture from the atmosphere. Also, another characteristic contained in chloride compounds is their low freezing points depending on concentration in a liquid solution. This results in reduced effects from the freeze-thaw cycles and minimized frost heaves, which can cause gravel roads to weaken (Monlux and Mitchell 2006).

Chloride compounds are reasonably simple to use and have additional benefits, such as improved ride, reduced sedimentation in streams, reduced aggregate loss, reduced inhalation hazards, reduced vehicle maintenance, and increased safety. These compounds are water soluble and can be washed out during wet weather cycles (Skorseth and Selim 2005).

2.4.1.3 Lignin Derivatives

Industrial waste products, animal fats, and vegetable oils make up these suppressants. The most common lignin derivative used is ligninsulfonate. Ligninsulfonate is a waste byproduct from the paper milling industry. Some personnel in the field refer to it as “tree sap.” It is said that lignin is the natural cement that holds the wood fibers of plants together. When the pulping process occurs, lignin polymers and wood sugars are released into the processing wastewater. The wastewater is referred to as ligninsulfonate. When used as a suppressant, the lignin polymers act as a binder for the soil particles. This keeps the dust particles glued together and they become harder to get airborne. Ligninsulfonate is water soluble and can be washed away during wet weather conditions (Addo, Sanders, and Chenard 2004) (Skorseth and Selim 2005).

2.4.1.4 Resinous Adhesives

These dust suppressants include byproducts from the plastic industry, waste oils, tars, and bitumen. The most widely used products are cutback asphalt and asphalt emulsions. Cutback asphalts are the result of a solvent added to asphalt cement. Different cutbacks are produced based on the type of solvent used. Rapid-curing cutback is the result of using highly volatile solvents such as gasoline or napthal. Medium and slow-curing cutbacks are created when lighter solvents such as kerosene are used. Asphalt emulsions are created by dispersing asphalts as small droplets of water. This is achieved by adding an emulsifying agent during the process. When resinous adhesives are used as dust suppressants, they create the most durable, dust free surfaces. This is due to their high cohesive properties and their insolubility to water. The use of these products was once popular but the amounts of fuel oil or kerosene in these products along with rising fuel costs has resulted in declined use and is being banned in many places. These products need to be applied by special asphalt application equipment (Addo, Sanders, and Chenard 2004).

Clays have also been used a dust suppressants. Clays have high plasticity and strong cohesion and work well when added to gravel in the right proportions. It is hard to haul and mix clay with gravel due to its high plasticity. For tars and bitumens, the structure and composition of the aggregates is the major factor that affects their cohesion in aggregate-asphalt mixes. A byproduct of soybean oil refining is also used as a dust suppressant. It is biodegradable and has many characteristics of light petroleum based oils. This product will penetrate the surface and create a light bond that reduces dust. There are also many other commercial products that may be used and should be tested on small sections of roadway before full use is decided upon (Skorseth and Selim 2005).

2.5 Dust Collection and Measurement

A majority of the research done with dust measurements has been focused in atmospheric pollution. Within the study of atmospheric pollution, dust measurements focus on two areas: 1) atmospheric modeling and prediction and 2) field measurement and quantification. The three main methods of air sampling techniques used by atmospheric pollution scientists are classified as sedimentation techniques, filtration techniques, and photometric techniques (Sanders and Addo 2000).

The sedimentation technique is a sampling method used for dust particle fallout from the atmosphere. These techniques follow ASTM D 1739 standards. Open-top containers, such as glass, metal, or plastic jars are used in this method. These containers have a height that is two to three times the diameter of the jar. Particulates are collected over an exposure period that is typically a month. The collected amount of particulate is expressed in terms of weight per unit area per 30 days. This technique depends on the forces of gravity and limits the particle size to about 2 µm or greater. There are a number of disadvantages to this technique as it requires an extended collection period for one sample, contaminated samples caused by foreign matter mixing with the collected dust, and the effect of winds on the samples (Sanders and Addo 2000).

The filtration technique employs the use of a suction source under a filter. The type of filter and the sampling equipment is dependent on the desired data and type of test being performed. An example of device that uses the filtration technique is the high volumetric sampler. The major drawback of this technique is that it requires the use of electric power to run the suction pump (Sanders and Addo 2000).

The photometric technique is based on the absorption properties of particulates passing though a light source. Basically, this technique looks at the light scattering as a sample passes through a light source. The amount of light scattered is dependent on the concentration, size, refractive index, shape, and color of the suspended particles.

The devices and techniques developed to measure road dust employ one or more of these particulate sampling techniques. In 1972, Wellman and Barraclough used the photometric technique to measure dust concentrations at a point along an unpaved road. Research performed by Hoover et al. in 1973 used the sedimentation technique by installing cups on the roadside of unpaved roads to gain data on the nature of dust generation and distribution. In 1984, Langon built a portable cyclone dust collector and mounted it on the rear of dust generating vehicle. The goal of this research was to use the filtration technique over a section of the road versus one point on the road. In 1986, the USDA Forest Service, in a cooperative study with Irwin et al. at Cornell University, developed a device that measured the road dust in terms of air opacity using photometric techniques. This device was called the Road Dust Monitor (RDM).

Between 1992 and 1995, a Mountain-Plains Consortium and department of transportation sponsored research project was undertaken by Thomas Sander and Jonathan Addo at Colorado State University. One objective of this project was to develop an inexpensive dust measuring device. Due to problems associated with the roadside bucket method of dust collection, a decision was made to develop a device to measure dust production from test sections that mounted on a vehicle and took real-time measurements. Modeling a device similar to the Langdon (1984) device, the Colorado State University Dustometer was created. The device and method were developed to generate quantitative and reproducible measurements that could be used to directly measure the dust mass in the field (Sanders and Addo 2000).

2.6 Cost Effectiveness of RAP Utilization

Recycled asphalt pavement (RAP) has been widely used in the United States since the 1970s and is a major benefit to the asphalt paving industry. The use of RAP allows for a lower mix material cost, elimination of the RAP disposal costs, and removal of a waste product from landfills. There are many additional benefits of using RAP including:

- Recycling material that would otherwise be disposed of at the taxpayers' expense, with a risk of harming the environment if disposed of improperly
- Maintaining original roadway geometrics
- Lowering the initial cost of the pavement by utilizing recycled binder and aggregate, which have a lower cost
- No sacrifice in the mix performance when the RAP is handled and incorporated into the mixture using the proper methods

Recycling asphalt pavements is currently the largest single recycling practice in the United States. In 2002, 30 million tons of RAP were used in hot mix asphalt (HMA) with a savings of over $300 million, accomplished by lowering material costs for the newly placed asphalt and eliminating the disposal cost of the RAP (Putnam, Aune, and Amirkhanian 2002).

2.7 Section Summary

Recycled asphalt pavement plays a significant role in the recycling world and the highway environment, yet, productive use of this material on gravel roads has remained limited. There is no significant research into the use of RAP on gravel roads, but it has the potential to provide an option in the fight to reduce dust loss and maintain roadway serviceability. Given the large amounts of RAP that is produced in Wyoming and the quantity of gravel roads, there is justification for further research into the use of RAP on gravel roads.

3. DESIGN OF STUDY AND TESTING PROCEDURES

3.1 Introduction

The objective of this research project was to explore the use of Recycled Asphalt Pavement (RAP) in gravel roads to help reduce dust loss while maintaining roadway serviceability. To accomplish this objective, field experiments were constructed in two counties in the state of Wyoming. Laramie County and Johnson County obtained RAP from WYDOT to use on some sections in their unpaved road network. The design of the sections utilizing RAP was developed by the individual county's road and bridge department in conjunction with the WYT^2 center.

Each section had three monitoring activities performed on them during the summer of 2008. Dust collection was taken using the Colorado State University (CSU) Dustometer. Surface distresses were observed following an established United States Army Corps of Engineers method. Roadway moisture content and wind characteristics were also collected on all sections. Laboratory testing was also performed by WYDOT on the materials used in the test sections. From these activities, the performance of RAP in gravel roads was evaluated.

3.2 Data Collection and Laboratory Testing

3.2.1 CSU Dustometer

Dust monitoring was accomplished using the CSU Dustometer. The Dustometer is a dust collection device that attaches behind the driver side rear wheel of the test vehicle. The Dustometer is an inexpensive moving dust sampler that was developed at CSU by Thomas Sanders and Jonathan Addo. It has been proven to be a quantitative, reproducible, and precise device for dust measurement (Sanders and Addo 1993).

The device consists of a fabricated steel filter box that contains glass microfiber filters; a standard high volumetric suction pump; a steel mounting bracket attached to the bumper of the test vehicle; a flexible hose for connecting the suction pump to the filter box; a gas-powered generator; an on/off switchbox for the suction pump; and a 2001 Chevy Suburban used as a testing vehicle. The steel filter box has an opening facing the rear wheel covered with a 200 µm mesh sieve screen that prevents large particles from entering the box during collection. The bottom of the filter box opens to allow access to the filter paper, which rests on another 200 µm mesh sieve screen that is mounted horizontally in the filter box (Morgan, Schaefer, and Sharma 2005). Figure 3.1 shows the CSU Dustometer with the clam shell open. Figures 3.2 and 3.3 show the University of Wyoming test vehicle setup.

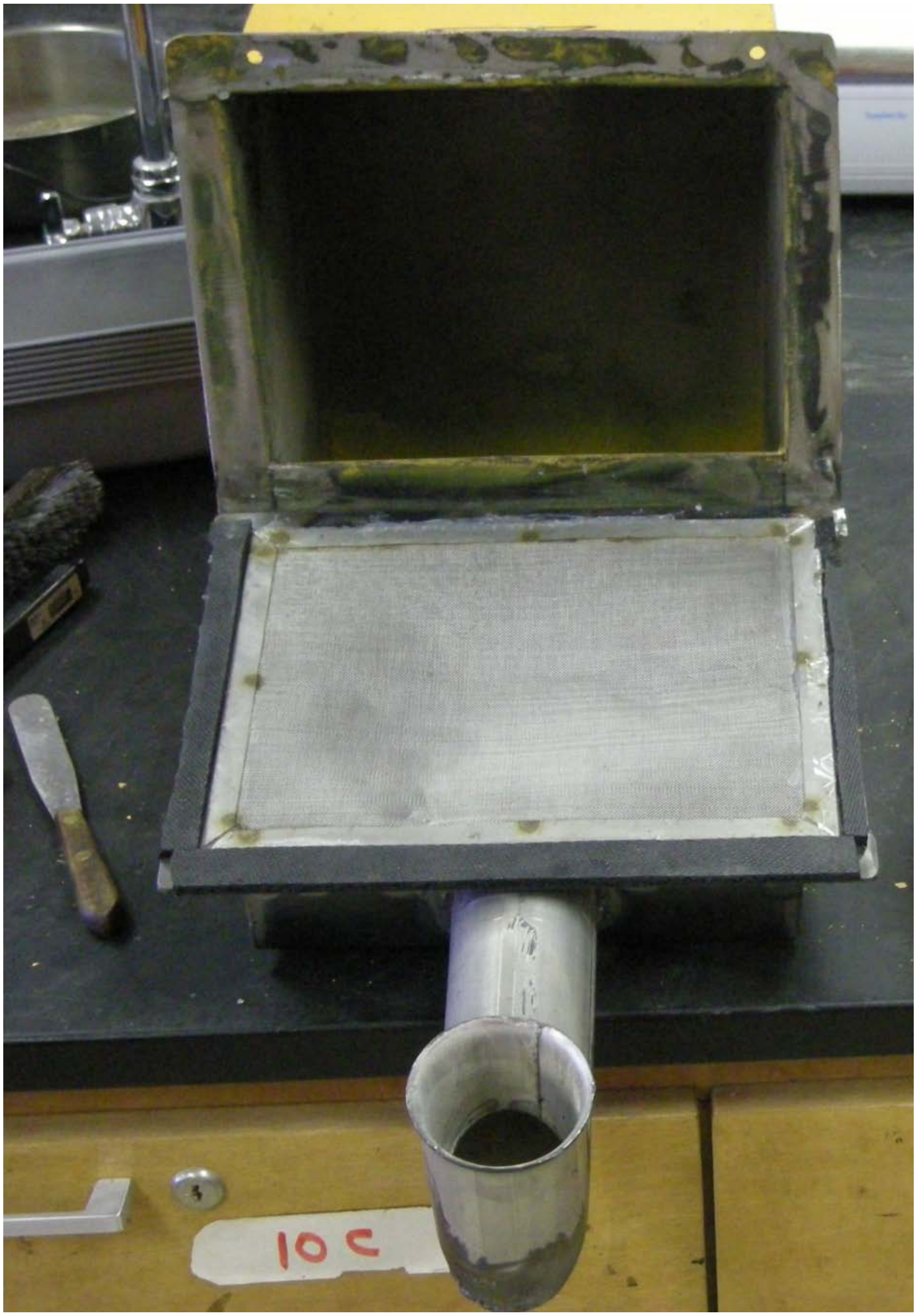

Figure 3.1 CSU Dustometer with Open Filter Box.

Figure 3.2 UW Test Vehicle: 2001 1/2 Ton Chevy Suburban.

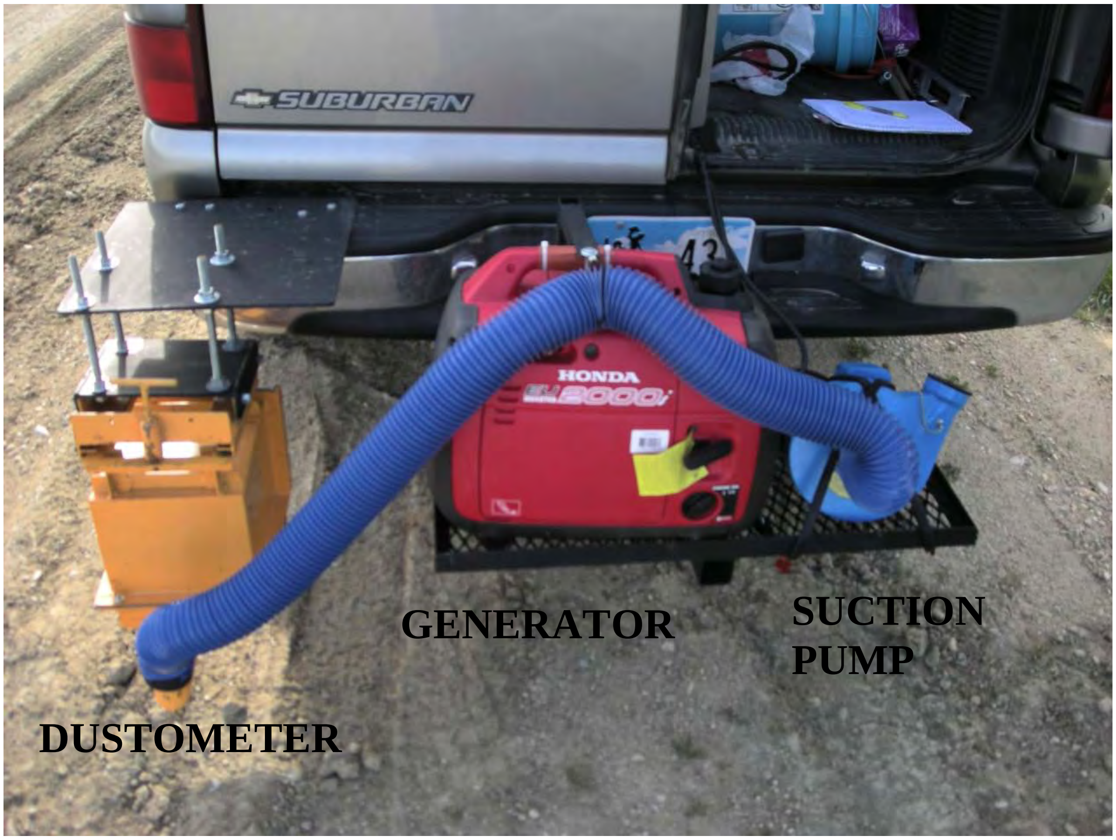

Figure 3.3 Complete CSU Dustometer Setup On Test Vehicle.

For each test, the 2001 half-ton Chevy Suburban was run at a test speed of 40 mph (64 km/hr) with a tire pressure of 50 psi (345 kPA) over one-half mile of the test section. Whatman EPM 2000 glass Microfibre filters were used. Dust data were collected by (1) weighing inside a gallon Baggie and recording; (2) setting up the Dustometer and making a run at 40 mph; (3) collecting the filter and sample in original gallon Baggie; and (4) re-weighing the Baggie with sample to find the dust sample weight in grams. All test sections had one dust measurement taken from each direction.

3.2.2 Environmental Factors

Environmental factors were collected on each section every time a dust measurement was taken. These factors include wind speed, wind direction, and surface moisture content. The wind characteristics were collected on site using a hand held compass and wind vane. The WindMate 200 by Speedtech Industries was used to collect this data. Road surface moisture content was collected by scraping off a sample of the road surface using a pick. A depth of no more than one inch (25 mm) was scraped off the surface and collected in a tin can. The tin can was taped off to seal in the moisture and returned to the lab. Each sample was weighed before and after drying, and the moisture content was calculated. Moisture content, wind speed, and wind direction were collected every time a dust measurement was performed.

3.2.3 Distress Survey

Surface distresses of each section were found using the methods presented in *Unsurfaced Road Maintenance Management* by Robert A. Eaton and Ronald E. Beaucham, USACE-CRREL Special Report 92-26, December 1992. A representative subsection of each test section (usually 100 feet) was determined and marked for monitoring. Each subsection was walked and all distresses were record every time field data were collected. The individual distresses were ranked according to the USACE methods, and a total unsurfaced road condition index (URCI) was established. The surface distresses were recorded on a field sheet that was developed by the USACE.

3.2.4 Material Characteristics

Samples of the materials used were collected. These samples were taken to the WYDOT Materials Testing Lab to be properly tested. Various tests were performed on the materials to determine the desired characteristics of a given material. The laboratory testing results were used to describe the materials and their relation to dust loss and surface distresses as described in Section 5.

Samples of RAP and RAP blends from the individual counties were collected from stockpiles using proper sample collection techniques. These samples were bagged, tagged and transferred to the WYDOT Materials Testing Lab in Cheyenne, WY. Lab technicians performed the necessary tests on the RAP and RAP blend materials to find the following characteristics of the material: gradation, R-value, oil percentage, and gradation after extraction of oil.

Samples of virgin aggregate from the individual counties were collected from stockpiles or the pit using proper sample collection techniques. These samples were transferred to the WYDOT Materials Testing Lab. Lab technicians performed the necessary tests on the virgin aggregate to find the following characteristics of the material: gradation, Atterburg Limits, cohesion value, fractured faces, R-value, along with the percentage of gravel, sand silt and clay.

The most important characteristic of the materials used in this research is the gradation of the materials. The percentage of material passing the #200 (0.075 mm) sieve is vital as it is this material that will become the airborne dust that is monitored. The material passing the #200 (0.075 mm) sieve also plays an important role in the binding component of gravel roads, especially when looking at surface distresses.

3.2.5 Traffic Counts

Traffic counts were collected from the individual county's Road and Bridge Department or by the WYT^2 center. Volume, speed, and vehicle classification on the three roads observed in this research project were collected. Traffic counters were in the field for a minimum of 10 days to provide adequate sampling. Traffic counts were taken during the summer months as it is during this time in which drilling, farming, and ranching activities are the most active.

3.3 Laramie County Experiment

The Laramie County Road and Bridge Department and the WYT^2 Center developed plans to use RAP on two county roads approximately 20 miles north of Cheyenne. Figure 3.4 shows a map of Wyoming with the Laramie County test site marked by a diamond in the southeast corner of the state. A total of five test sections were constructed in April 2008. Three of the sections were on County Road 224, also known as Atlas Road. The other two sections were on County Road 124 also known as Pry Road. The RAP used came from a stockpile near Atlas Road that was milled from nearby I-25. The aggregate used in the existing 100% gravel roadway came from a pit near Atlas Road. An overview of the area for the Laramie County test sites can be found in Figure 3.5.

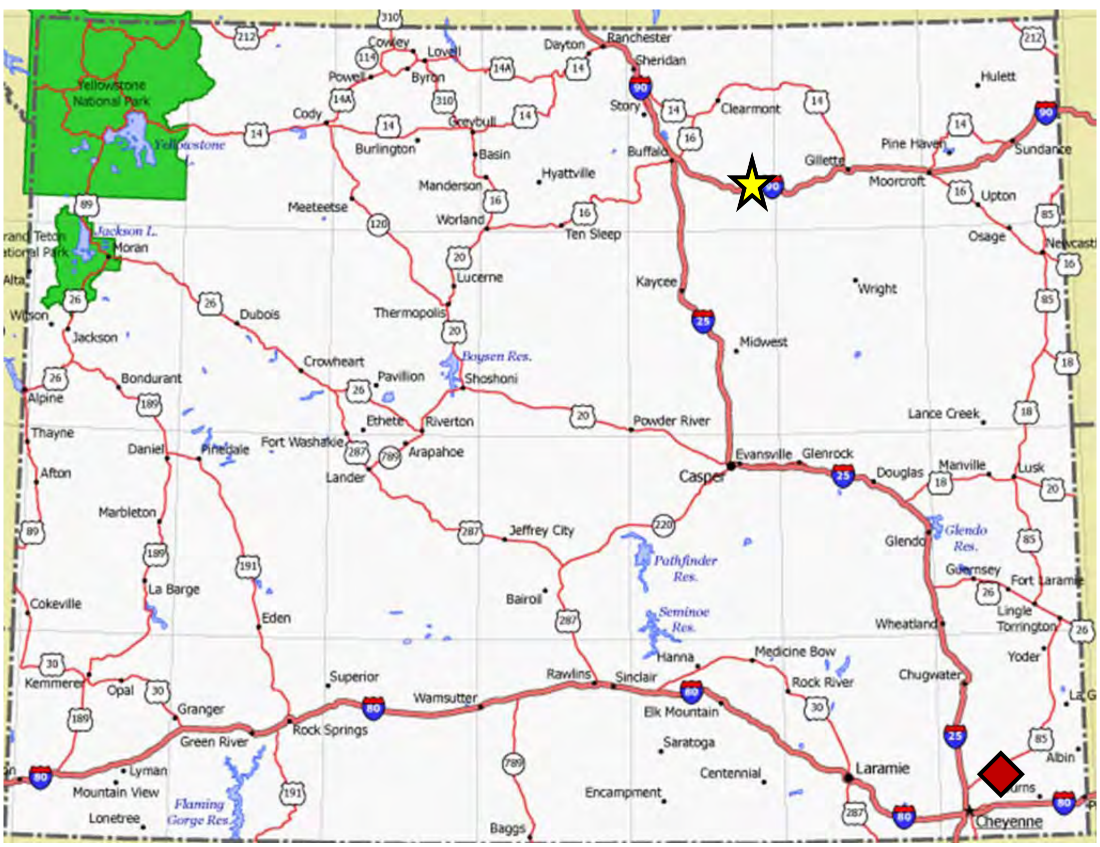

Figure 3.4 Test Site Locations on State Map of Wyoming.

Figure 3.5 Overview of Laramie County Test Site.

Of the five total test sections in Laramie County, three consisted of blended RAP and gravel while the other two contained 100% gravel to be used as control sections. The RAP blend sections were all blended on site. The construction process consisted of (1) scarifying the existing 100% gravel roadway with a motor grader, (2) hauling and dumping a calculated volumetric depth of pure RAP onto the scarified roadway, (3) blending the RAP and aggregate using the blade on a motor grader, (4) shaping the road with the newly created RAP blend, and (5) letting traffic compact the roadway. No additional dust abatement measures were taken on the test sections.

The results of construction on Atlas Road consisted of three sections: two different RAP blends and one 100% gravel control. One RAP blend section consisted of a volumetric depth of 2½ inches (62.5 mm) of RAP blended with the existing surface. The total length of the section was 0.6 miles, and it was named A2. The other RAP blend section consisted of a volumetric depth of 1½ inches (37.5 mm) of RAP blended with the existing surface. The total length of the section was 0.7 miles, and it was named A1.

Finally, the remaining 0.7 miles of Atlas Road consisted of 100% gravel. This control section was named A0. Figure 3.6 shows the test sections on Atlas Road.

Figure 3.6 Atlas Road Test Sections.

The results of construction on Pry Road consisted of two sections: one RAP blend and one 100% gravel control. The RAP blend section consisted of a volumetric depth of 1½ inches (37.5 mm) of RAP blended with the existing surface. The total length of the section was 0.8 miles, and it was named P1. The 100% gravel control section had a length of 1.2 miles, and was named P0. Figure 3.7 shows the test sections on Pry Road.

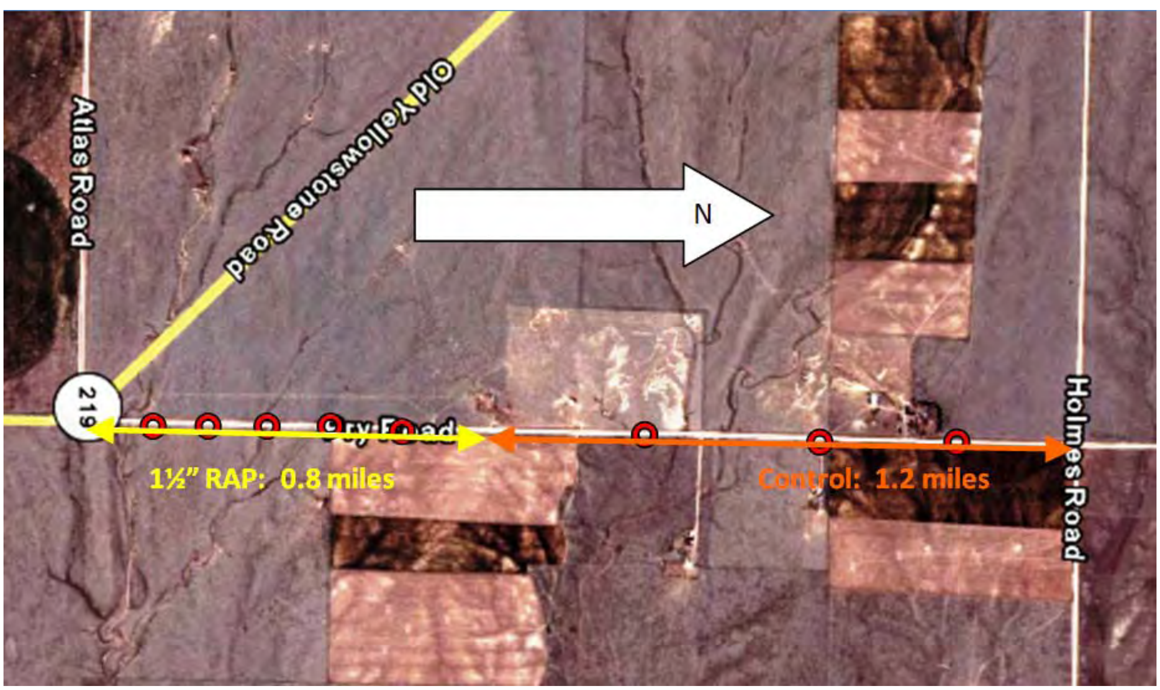

Figure 3.7 Test Sections on Pry Road.

Although each test section in Laramie County was longer than one-half mile, only one-half of a mile was used for testing. The beginning and end of each half mile test section was clearly marked using painted wood stakes in the ditch and brightly colored tape on the fence line. Field data were collected and monitored on each section independently.

3.4 Johnson County Experiment

The Johnson County Road and Bridge Department and the WYT^2 Center developed plans to use RAP on Schoonover Road approximately 20 miles east of Buffalo, WY. Figure 3.4 above shows a map of the State of Wyoming with the Johnson County test site marked by a star in the northern part of the state. A total of three sections were constructed in June 2008. All three sections were constructed back to back. Two contained RAP blends and the third was a 100% gravel control. The addition of calcium chloride (CaCl) was used on two of the test sections.

The construction process in Johnson County was much different than that in Laramie County. The construction process on Schoonover Road consisted of (1) mixing RAP with virgin aggregate off-site in a pugmill with a 1 to 1 ratio resulting in 50% RAP and 50% virgin aggregate blend; (2) hauling the RAP blend onto site and dumping on the existing roadway; (3) using the blade on a motor grader to spread the RAP blend and shape the roadway; and (4) using a vibratory drum roller to compact the roadway surface.

Two weeks after construction, CaCl was applied to the appropriate sections. This process consisted of (1) wetting the roadway surface using a water truck; (2) spreading CaCl flakes on the wet roadway; (3) making another pass with the water truck; and (4) letting the CaCl leach into the roadway surface as the water dries off. CaCl was applied to one RAP blend section and the rest of the existing 100% gravel road.

The result of construction was three test sections. All the sections had a length of one-half mile. One section was a RAP blend section with no CaCl applied, and it was named S2. Another section was a RAP blend section with CaCl, and it was named S1. Finally, the third section was the 100% gravel with CaCl control section, and it was named S0. A section of 100% gravel without CaCl was not constructed due the heavy traffic experienced on Schoonover Road, especially truck traffic. Field data were collected and monitored on each section independently. Figure 3.8 gives a visual overview of the Johnson County test sections on Schoonover Road.

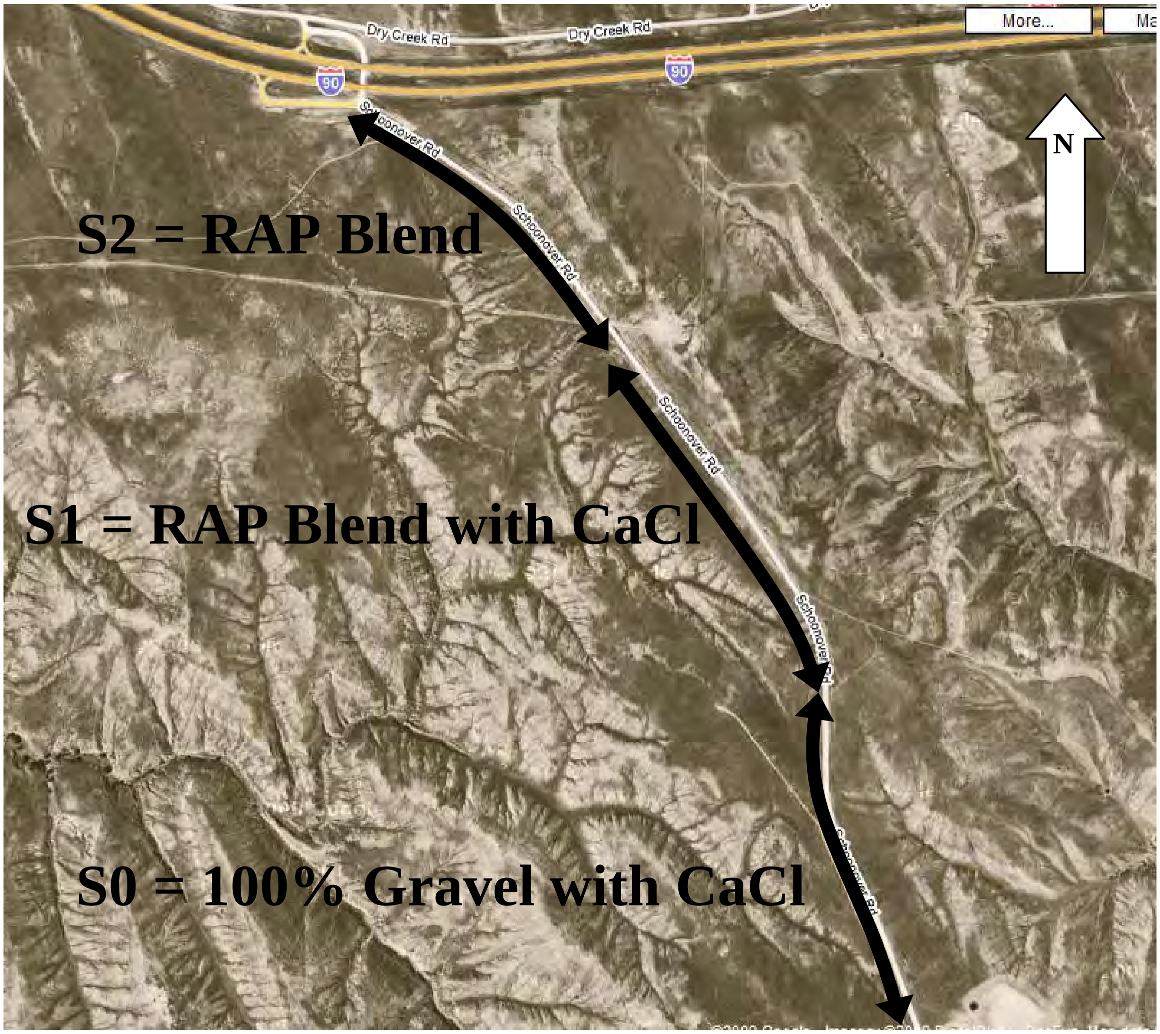

Figure 3.8 Test Sections on Schoonover Road.

3.5 Section Summary

This chapter described the strategies and construction techniques used to evaluate the use of RAP in gravel roads. Each section in this study was monitored independently. The CSU Dustometer was used to collect dust data. A method developed by the USACE was used to evaluate surface distresses. A handheld instrument was used to collect environmental conditions. Surface samples were taken to calculate the moisture content of the roadway. Traffic data were collected by the local agencies and the WYT^2 Center. Several test sections in two counties in Wyoming were constructed using different techniques for utilizing RAP in gravel roads. These techniques were used to collect the necessary data on each section in order to evaluate the use of RAP in gravel roads.

4. DATA COLLECTION

4.1 Introduction

Field and laboratory data were collected in this research project to evaluate the performance of RAP in gravel roads. The field evaluation was accomplished by observing and collecting data on the test sections constructed in Laramie and Johnson Counties. Traffic data were provided by the individual county or the WYT^2 Center. Dust measurements, surface surveys, and environmental factors were collected by the WYT^2 Center.

The laboratory testing of material was conducted by the WYDOT Materials Testing Lab in Cheyenne, WY. Lab technicians performed the necessary tests on the materials to provide the desired characteristics of the material. One of the main purposes of this testing was to provide the gradations of the various materials. The tests performed followed the appropriate AASHTO and ASTM testing procedures. Wyoming modified AASHTO and ASTM testing procedures were used where applicable.

4.2 Material Characteristics

To determine the characteristics of the materials used in this project, lab testing performed by WYDOT was utilized. All materials had a sieve analysis performed to determine the gradation of the material. Materials that contained RAP had different tests than the virgin aggregates due to the nature of the material and the testing. The following sections will break down the results of the lab testing.

4.2.1 Recycled Asphalt Pavement

RAP samples were collected for both Laramie and Johnson Counties. Gradation before and after extraction of the oil was desired, along with the R-value for strength of the material and the percentage of oil in the RAP. Table 4.1 summarizes the laboratory results for the RAP used in Laramie County. Figure 4.1 shows the gradation of the RAP used in Laramie County. No samples of the RAP used in Johnson County were taken as all of the material used was already blended with 100% virgin aggregate. Please refer to Appendix C for the complete data set.

From the laboratory results and gradation, it can be seen that the RAP material has less than 1% of the total material passing the #200 (0.075mm) sieve. Therefore, the amount of fines found in the RAP material is very small. Also, from Figure 4.1 it can be seen that the RAP is well graded. These characteristics make the RAP a suitable addition to gravel roads for reducing dust loss.

Table 4.1 Laramie County Recycled Asphalt Pavement Lab Results

Laramie County - Atlas and Pry Roads				
Sieve Size	**Percent Passing**			
	RAP Windrow			
	A2	**A1**	**P1**	**Average**
2 in. (50.8 mm)	100.0	100.0	100.0	100.0
1 1/2 in. (38.1 mm)	97.9	99.5	100.0	99.1
1 in. (25.4 mm)	94.7	97.4	98.3	96.8
3/4 in. (19.0 mm)	92.3	94.5	95.8	94.2
1/2 in. (12.7 mm)	80.0	82.3	83.5	81.9
3/8 in. (9.5 mm)	72.1	74.4	75.8	74.1
No. 4 (4.75 mm)	44.2	48.0	49.8	47.3
No. 8 (2.38 mm)	32.5	33.3	29.6	31.8
No. 16 (1.19 mm)	22.1	21.9	16.9	20.3
No. 30 (0.595 mm)	13.3	13.3	8.5	11.7
No. 50 (0.297 mm)	5.9	6.8	3.0	5.2
No. 100 (0.149 mm)	2.2	2.8	1.0	2.0
No. 200 (0.075 mm)	0.8	0.9	0.4	0.7
	Sample A	**Sample B**	**Sample C**	**Average**
R - Value	76.0	77.0	79.0	77.3
% Oil	5.85	5.59	5.88	5.77
Sieve Size	**Percent Passing After Oil Extraction**			
	RAP Windrow			
	Sample A	**Sample B**	**Sample C**	**Average**
3/4 in. (19.0 mm)	100.0	100.0	100.0	100.0
1/2 in. (12.7 mm)	93.3	91.7	92.3	92.4
3/8 in. (9.5 mm)	88.4	84.4	88.0	86.9
No. 4 (4.75 mm)	63.5	60.3	63.9	62.6
No. 8 (2.38 mm)	47.5	44.6	48.3	46.8
No. 16 (1.19 mm)	36.3	33.9	36.5	35.6
No. 30 (0.595 mm)	27.8	25.9	27.6	27.1
No. 50 (0.297 mm)	20.0	18.6	19.8	19.5
No. 100 (0.149 mm)	13.4	12.5	13.5	13.1
No. 200 (0.075 mm)	8.9	8.3	9.3	8.8

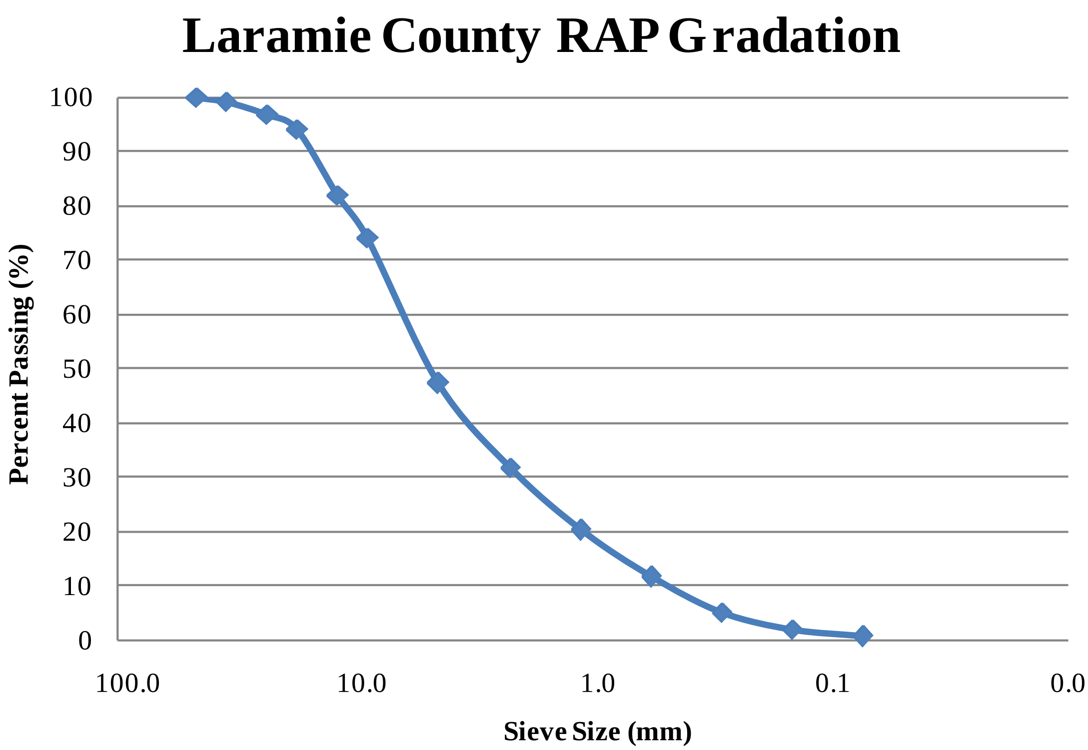

Figure 4.1 Gradation of RAP Material Used in Laramie County.

4.2.2 Virgin Aggregate

Virgin aggregate samples were collected for both Laramie County and Johnson County. Gradation, Atterburg Limits, cohesion value, fractured faces, R-value, percentage of gravel, sand, silt, and clay were determined. Table 4.2 summarizes the lab results for the virgin aggregate used in Laramie County and Table 4.3 summarizes the lab results for the virgin aggregate used in Johnson County. Figure 4.2 contains the gradations of the gravel used in Laramie and Johnson Counties. Please refer to Appendix C for the complete data set.

Table 4.2 Laramie County 100% Gravel Laboratory Results

Laramie County - Atlas and Pry Roads			
Sieve Size	Percent Passing		
	100 % Gravel Control		
	Atlas	**Pry**	**Average**
1 1/2 in. (38.1 mm)	100.0	100.0	100.0
1 in. (25.4 mm)	99.8	99.4	99.6
3/4 in. (19.0 mm)	99.4	98.6	99.0
1/2 in. (12.7 mm)	97.6	96.4	97.0
3/8 in. (9.5 mm)	95.3	93.7	94.5
No. 4 (4.75 mm)	78.1	76.1	77.1
No. 8 (2.38 mm)	65.1	65.1	65.1
No. 16 (1.19 mm)	54.8	57.7	56.2
No. 30 (0.595 mm)	45.2	49.7	47.4
No. 50 (0.297 mm)	35.4	40.1	37.7
No. 100 (0.149 mm)	29.3	32.7	31.0
No. 200 (0.075 mm)	22.4	23.6	23.0
	Atlas	**Pry**	**Average**
Liquid Limit (LL)	26.5	27.0	26.8
Plasticity Index (PI)	11.5	11.0	11.3
Cohesion Value (CV) psi	340.5	164.0	252.3
Fractured Faces (FF) %	Insuffcient Material		
R - Value	30.0	26.0	28.0
% Gravel	0.3	0.0	0.2
% Sand	62.4	60.2	61.3
% Silt	23.2	26.5	24.9
% Clay	14.2	13.8	14.0

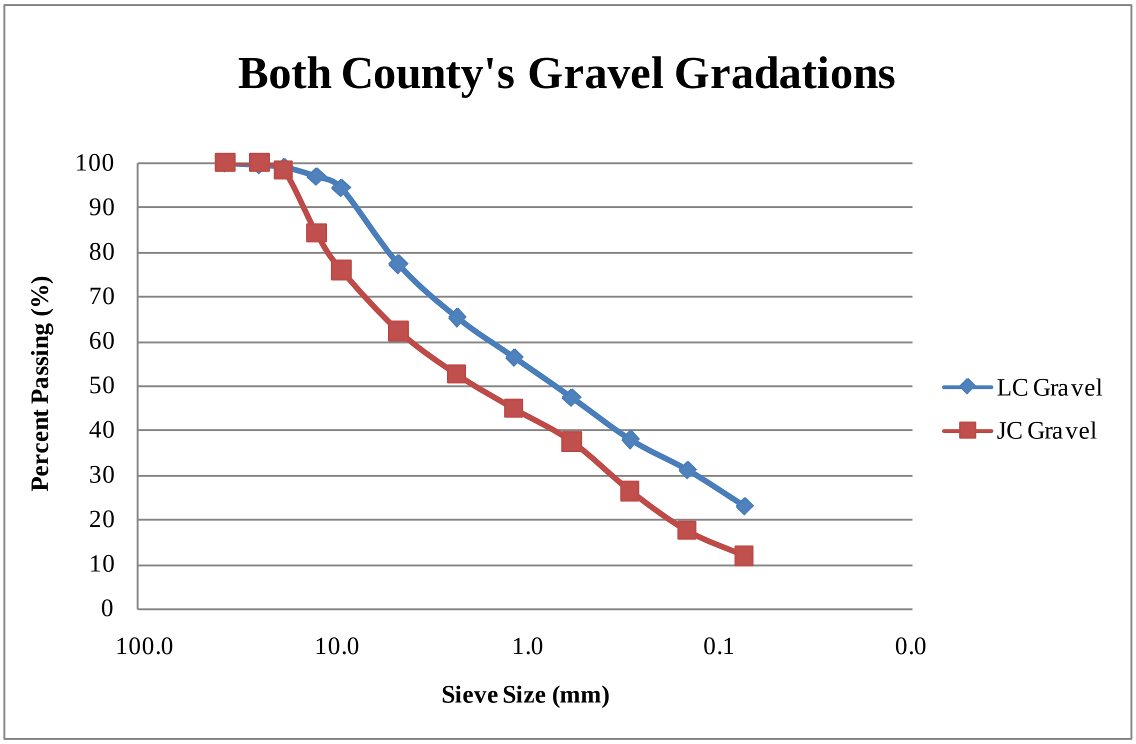

Figure 4.2 Gradations of Gravel Used in Laramie and Johnson Counties.

The gravel used in Laramie County has two times more material passing the #200 (0.075mm) sieve than the gravel in Johnson County. This would imply that the Laramie County test sections were expected to have more dust loss than Johnson County test sections as there was more available material to become airborne. Also, the percentage of fine material in the gravel used in Laramie County is much greater than the percentage of fine material in the RAP used in Laramie County by almost 200%.

Table 4.3 Johnson County 100% Virgin Aggregate Laboratory Results

Johnson County - Schoonover Road				
Sieve Size	**Percent Passing**			
	Stockpiled Virgin Aggregate			
	Sample A	**Sample B**	**Sample C**	**Average**
1 1/2 in. (38.1 mm)	100.0	100.0	100.0	100.0
1 in. (25.4 mm)	100.0	100.0	99.8	99.9
3/4 in. (19.0 mm)	98.0	98.4	98.0	98.1
1/2 in. (12.7 mm)	83.5	86.0	82.5	84.0
3/8 in. (9.5 mm)	75.7	77.7	73.8	75.7
No. 4 (4.75 mm)	62.1	63.7	60.6	62.1
No. 8 (2.38 mm)	50.5	53.9	52.8	52.4
No. 16 (1.19 mm)	42.8	46.0	45.5	44.8
No. 30 (0.595 mm)	35.8	38.2	38.0	37.3
No. 50 (0.297 mm)	25.7	26.4	26.3	26.1
No. 100 (0.149 mm)	17.0	17.4	17.4	17.3
No. 200 (0.075 mm)	11.5	11.3	12.0	11.6
	Sample A	**Sample B**	**Sample C**	**Average**
Liquid Limit (LL)	NV	NV	NV	NV
Plasticity Index (PI)	NP	NP	NP	NP
Cohesion Value (CV) psi	517.0	400.0	420.0	445.7
Fractured Faces (FF) %	89.1	91.6	90.2	90.3
R - Value	74.0	79.0	71.0	74.7
% Gravel	0.0	0.3	0.4	0.2
% Sand	75.3	72.1	78.8	75.4
% Silt	18.7	21.4	14.9	18.3
% Clay	6.0	6.2	5.9	6.0

4.2.3 RAP Blend

RAP blend samples were collected for both Laramie County and Johnson County. Gradation before and after extraction of the oil were desired along with the R-value for strength of the material and the percentage of oil in the RAP blend. Table 4.4 summarizes the lab results for the RAP blend used in Laramie County and Table 4.5 summarizes the lab results for the RAP blend used in Johnson County. Figure 4.3 contains the gradations of the RAP blends used in Laramie and Johnson Counties. Please refer to Appendix C for the complete data set.

Table 4.4 Laramie County RAP Blend Lab Results

Laramie County - Atlas and Pry Roads				
Sieve Size	**Percent Passing**			
	RAP Blended Surface			
	A2	**A1**	**P1**	**Average**
3 in. (76.2 mm)	100.0	100.0	100.0	100.0
2 in. (50.8 mm)	100.0	99.5	100.0	99.8
1 1/2 in. (38.1 mm)	100.0	99.5	100.0	99.8
1 in. (25.4 mm)	98.4	98.8	99.2	98.8
3/4 in. (19.0 mm)	96.8	97.7	98.2	97.6
1/2 in. (12.7 mm)	88.1	88.3	91.8	89.4
3/8 in. (9.5 mm)	81.6	81.7	86.5	83.3
No. 4 (4.75 mm)	54.8	56.3	62.9	58.0
No. 8 (2.38 mm)	33.8	42.5	50.2	42.2
No. 16 (1.19 mm)	19.7	31.5	38.7	30.0
No. 30 (0.595 mm)	10.9	21.8	27.0	19.9
No. 50 (0.297 mm)	5.1	13.1	15.4	11.2
No. 100 (0.149 mm)	2.3	7.0	7.4	5.6
No. 200 (0.075 mm)	1.0	2.9	2.7	2.2
	A2	**A1**	**P1**	**Average**
R - Value	78.0	73.0	78.0	76.3
% Oil	4.18	4.61	4.07	4.29
Sieve Size	**Percent Passing After Oil Extraction**			
	RAP Blended Surface			
	A2	**A1**	**P1**	**Average**
1 in. (25.4 mm)	100.0	100.0	100.0	100.0
3/4 in. (19.0 mm)	99.4	99.7	100.0	99.7
1/2 in. (12.7 mm)	92.4	92.8	97.4	94.2
3/8 in. (9.5 mm)	89.1	87.0	92.7	89.6
No. 4 (4.75 mm)	67.9	65.4	74.3	69.2
No. 8 (2.38 mm)	53.9	51.3	58.7	54.6
No. 16 (1.19 mm)	42.6	40.5	45.8	43.0
No. 30 (0.595 mm)	33.6	31.7	34.9	33.4
No. 50 (0.297 mm)	24.8	23.3	25.0	24.4
No. 100 (0.149 mm)	17.4	16.1	17.6	17.0
No. 200 (0.075 mm)	11.3	10.4	12.0	11.2

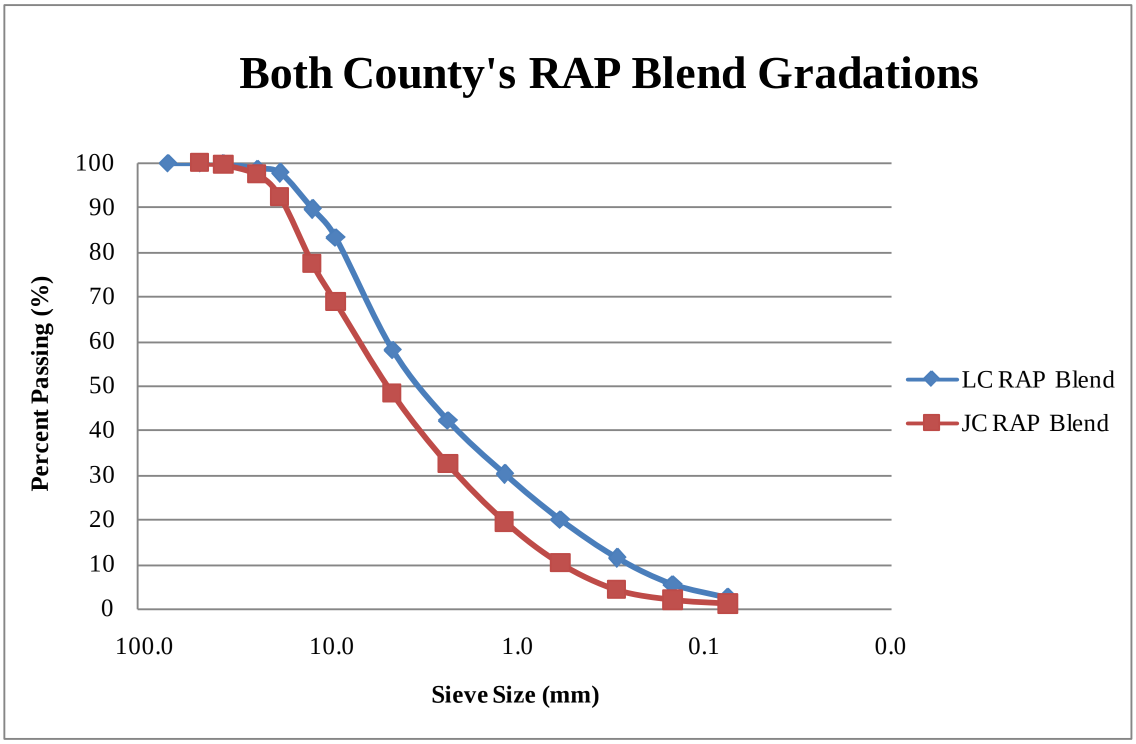

Figure 4.3 Gradations of RAP Blend Used in Laramie and Johnson Counties.

The percentage of RAP blend material that passed the #200 (0.075mm) sieve was greater for Laramie County compared with Johnson County by 220%. This suggests that the RAP blended sections in Laramie County should have more dust loss than those in Johnson County.

Table 4.5 Johnson County RAP Blend Lab Results

Johnson County - Schoonover Road				
Sieve Size	**Percent Passing**			
	RAP Virgin Blend			
	Sample A	**Sample B**	**Sample C**	**Average**
2 in. (50.8 mm)	100	100	100	100
1 1/2 in. (38.1 mm)	99.5	100.0	99.4	99.6
1 in. (25.4 mm)	97.0	98.5	96.5	97.3
3/4 in. (19.0 mm)	91.8	94.4	90.8	92.3
1/2 in. (12.7 mm)	76.6	80.2	74.7	77.2
3/8 in. (9.5 mm)	68.1	71.6	66.1	68.6
No. 4 (4.75 mm)	48.4	48.9	47.4	48.2
No. 8 (2.38 mm)	36.0	28.2	33.1	32.4
No. 16 (1.19 mm)	23.3	14.0	20.9	19.4
No. 30 (0.595 mm)	12.5	6.8	11.0	10.1
No. 50 (0.297 mm)	4.8	3.5	4.5	4.3
No. 100 (0.149 mm)	1.8	1.9	1.8	1.8
No. 200 (0.075 mm)	0.7	1.5	0.8	1.0
	Sample A	**Sample B**	**Sample C**	**Average**
R - Value	78.0	79.0	80.0	79.0
% Oil	2	2.4	2.15	2.2
Sieve Size	**Percent Passing After Oil Extraction**			
	RAP Virgin Blend			
	Sample A	**Sample B**	**Sample C**	**Average**
1 in. (25.4 mm)	100.0	100.0	100.0	100.0
3/4 in. (19.0 mm)	100.0	98.2	97.3	98.5
1/2 in. (12.7 mm)	83.7	80.6	78.7	81.0
3/8 in. (9.5 mm)	76.5	73.3	78.7	76.2
No. 4 (4.75 mm)	56.9	55.9	53.3	55.4
No. 8 (2.38 mm)	46.7	47.9	45.2	46.6
No. 16 (1.19 mm)	34.7	38.5	35.5	36.2
No. 30 (0.595 mm)	24.6	29.0	25.6	26.4
No. 50 (0.297 mm)	16.4	19.0	16.4	17.3
No. 100 (0.149 mm)	10.3	11.8	9.8	10.6
No. 200 (0.075 mm)	7.2	7.2	5.7	6.7

4.2.4 Material Comparison to WYDOT Gradation Requirements

Table 4.6 contains a summary of the materials used in the test sections. Table 4.6 also contains the gradation requirements for gravel roads (Grading GR) from the WYDOT *Standard Specifications for Road and Bridge Construction, 2003 Edition.* The gradations of the RAP blends consist of the materials after the oil was chemically extracted. The RAP blends after chemical extraction in both counties are within specifications for WYDOT Grading GR, except that the one-half inch (12.7mm) material in Laramie County is a little high. This has no particular influence on dust loss or road serviceability as it the material smaller than the #4 (4.75 mm) sieve that is important. The gravel used in Johnson County meets the Grading GR specifications with the exception of the #30 (0.595mm) material having 37.3%, passing while the high end of the specification is 35% passing. The gravel used in Laramie County is on the high end of the Grading GR specifications with the majority of the materials not falling within the specification range. This is important when looking at the fines, especially the #200 (0.075mm) sieve, because there is more material available to be lost as dust. This will lead to more dust loss in Laramie County compared with Johnson County.

Table 4.6 Summary of Gradations and WYDOT Grading GR Specifications

Sieve Size	Percent Passing				
	Laramie County Gravel	**Laramie County RAP Blend After Extraction**	**Johnson County Gravel**	**Johnson County RAP Blend After Extraction**	**WYDOT Grading GR**
1 1/2 in. (38.1 mm)	100.0	100.0	100.0	100.0	
1 in. (25.4 mm)	99.6	100.0	99.9	100.0	100.0
3/4 in. (19.0 mm)	99.0	99.7	98.1	98.5	90 to 100
1/2 in. (12.7 mm)	97.0	94.2	84.0	81.0	65 to 85
3/8 in. (9.5 mm)	94.5	89.6	75.7	76.2	
No. 4 (4.75 mm)	77.1	69.2	62.1	55.4	50 to 78
No. 8 (2.38 mm)	65.1	54.6	52.4	46.6	37 to 67
No. 16 (1.19 mm)	56.2	43.0	44.8	36.2	
No. 30 (0.595 mm)	47.4	33.4	37.3	26.4	13 to 35
No. 50 (0.297 mm)	37.7	24.4	26.1	17.3	
No. 100 (0.149 mm)	31.0	17.0	17.3	10.6	
No. 200 (0.075 mm)	23.0	11.2	11.6	6.7	4 to 15

4.2.5 Materials on the Test Sections

Table 4.7 gives the gradations of the roadway surfaces that were used in both counties. Both Laramie and Johnson County had test sections with 100% gravel and RAP blends. The gradations of the RAP blended material are before chemical extraction of the oil was performed. The amount of material passing the #200 (0.075mm) sieve for the gravel used in Laramie County is twice as much as that in Johnson County. This also holds true for the RAP blended sections. The result will be more material available to be lost as dust in Laramie County than in Johnson County. Also, the amount of fines in the RAP blends is minimal as there is asphalt cement within the blend that is binding the materials together and making the blend suitable for application on gravel roads.

Table 4.7 Comparison of the Materials on the Test Sections

Sieve Size	Percent Passing			
	Laramie County Gravel	Laramie County RAP Blend	Johnson County Gravel	Johnson County RAP Blend
3 in. (76.2 mm)	100.0	100.0	100.0	100.0
2 in. (50.8 mm)	100.0	99.8	100.0	100.0
1 1/2 in. (38.1 mm)	100.0	99.8	100.0	99.6
1 in. (25.4 mm)	99.6	98.8	99.9	97.3
3/4 in. (19.0 mm)	99.0	97.6	98.1	92.3
1/2 in. (12.7 mm)	97.0	89.4	84.0	77.2
3/8 in. (9.5 mm)	94.5	83.3	75.7	68.6
No. 4 (4.75 mm)	77.1	58.0	62.1	48.2
No. 8 (2.38 mm)	65.1	42.2	52.4	32.4
No. 16 (1.19 mm)	56.2	30.0	44.8	19.4
No. 30 (0.595 mm)	47.4	19.9	37.3	10.1
No. 50 (0.297 mm)	37.7	11.2	26.1	4.3
No. 100 (0.149 mm)	31.0	5.6	17.3	1.8
No. 200 (0.075 mm)	23.0	2.2	11.6	1.0

4.3 Dust Measurement, Moisture Content, Wind Speed, Wind Direction

Dust measurements were collected using the CSU Dustometer. Every time a dust measurement was taken the moisture content of the road surface was collected. Wind speed and direction were also collected with each run of the Dustometer using a hand held wind vane and compass. Table 4.8 gives a sample of the dust, moisture content, and wind data collected for the Laramie County test sections.

Table 4.9 presents a sample of the dust, moisture content, and wind data collected for the Johnson County test sections. Please refer to Appendix A for the complete set of collected data.

Table 4.8 Sample of Dust, Wind, and Moisture Data Collected in Laramie County

Laramie County Dust, Moisture, and Wind Data						
#	Test Section	Date of Sample	Time of Sample	Wind (mph)	1 mi. Dust Wt. (g)	Moisture Content (%)
1	Atlas Road - A2 (2 1/2" RAP)	6/9/2008	7:55 AM	20 W	1.82	2.044
2	Atlas Road - A1 (1 1/2" RAP)	6/9/2008	8:10 AM	20 W	6.20	0.991
3	Atlas Road - A0 (100% Gravel)	6/9/2008	8:25 AM	20 W	5.78	2.591
4	Pry Road - P1 (1 1/2" RAP)	6/9/2008	8:30 AM	20 W	0.64	2.105
5	Pry Road - P0 (100% Gravel)	6/9/2008	8:35 AM	20 W	0.38	2.549
6	Atlas Road - A2 (2 1/2" RAP)	6/17/2008	7:25 AM	10 W	3.86	0.477
7	Atlas Road - A1 (1 1/2" RAP)	6/17/2008	7:30 AM	10 W	6.52	0.645
8	Atlas Road - A0 (100% Gravel)	6/17/2008	7:40 AM	10 W	3.76	1.029
9	Pry Road - P1 (1 1/2" RAP)	6/17/2008	7:45 AM	10 W	0.88	0.767
10	Pry Road - P0 (100% Gravel)	6/17/2008	7:50 AM	10 W	0.92	1.314
11	Atlas Road - A2 (2 1/2" RAP)	6/24/2008	7:10 AM	10 WNW	2.40	6.362
12	Atlas Road - A1 (1 1/2" RAP)	6/24/2008	7:20 AM	10 WNW	1.58	3.385
13	Atlas Road - A0 (100% Gravel)	6/24/2008	7:30 AM	10 WNW	2.40	5.044
14	Pry Road - P1 (1 1/2" RAP)	6/24/2008	7:35 AM	10 WNW	2.34	4.936
15	Pry Road - P0 (100% Gravel)	6/24/2008	7:40 AM	10 WNW	5.84	5.523
16	Atlas Road - A2 (2 1/2" RAP)	7/11/2008	7:40 AM	15 W	2.20	0.736
17	Atlas Road - A2 (2 1/2" RAP)	7/28/2008	8:45 AM	16 WNW	0.76	0.662
18	Atlas Road - A1 (1 1/2" RAP)	7/28/2008	8:40 AM	20 W	0.42	0.777
19	Atlas Road - A0 (100% Gravel)	7/28/2008	8:30 AM	20 WNW	0.96	1.193
20	Pry Road - P1 (1 1/2" RAP)	7/28/2008	9:15 AM	11 WNW	0.64	0.605

Table 4.9 Sample of Dust, Wind, and Moisture Data Collected in Johnson County

Johnson County Dust, Moisture Content, and Wind Data						
#	Test Section	Date of Sample	Time of Sample	Wind (mph)	1 mi. Dust Wt. (g)	Moisture Content (%)
1	Section 1 & 2 of RAP (no dust abatement)	6/9/2008	2:15 PM	10 NNW	1.50	2.117
2	Section 1 & 2 of RAP (no dust abatement)	6/11/2008	9:05 AM	10 NNW	0.77	1.904
3	Section 1 & 2 of RAP (no dust abatement)	6/17/2008	12:45 PM	10 NNW	1.84	0.316
4	Schoonover Road - S0 (100% Gravel w/ CaCl)	7/14/2008	12:45 PM	15 NNW	1.08	1.657
5	Schoonover Road - S2 (RAP Blend)	7/28/2008	4:00 PM	5 N	0.54	0.348
6	Schoonover Road - S1 (RAP Blend w/ CaCl)	7/28/2008	4:10 PM	5 N	0.26	1.692
7	Schoonover Road - S0 (100% Gravel w/ CaCl)	7/28/2008	4:20 PM	5 N	0.46	1.282
8	Schoonover Road - S2 (RAP Blend)	7/28/2008	4:35 PM	5 N	0.54	0.348
9	Schoonover Road - S1 (RAP Blend w/ CaCl)	7/28/2008	4:30 PM	5 N	0.48	1.692
10	Schoonover Road - S0 (100% Gravel w/ CaCl)	7/28/2008	4:25 PM	5 N	1.04	1.282
11	Schoonover Road - S2 (RAP Blend)	7/29/2008	9:45 AM	0	0.86	0.504
12	Schoonover Road - S1 (RAP Blend w/ CaCl)	7/29/2008	9:50 AM	0	0.48	1.569
13	Schoonover Road - S0 (100% Gravel w/ CaCl)	7/29/2008	9:55 AM	0	1.52	1.741
14	Schoonover Road - S2 (RAP Blend)	7/29/2008	9:40 AM	0	0.50	0.504
15	Schoonover Road - S1 (RAP Blend w/ CaCl)	7/29/2008	9:30 AM	0	0.50	1.569
16	Schoonover Road - S0 (100% Gravel w/ CaCl)	7/29/2008	9:20 AM	0	1.36	1.741
17	Schoonover Road - S2 (RAP Blend)	8/6/2008	3:20 PM	3 N	0.64	0.331
18	Schoonover Road - S1 (RAP Blend w/ CaCl)	8/6/2008	3:15 PM	4 NE	0.28	1.297
19	Schoonover Road - S0 (100% Gravel w/ CaCl)	8/6/2008	3:10 PM	3 NE	0.98	0.698
20	Schoonover Road - S2 (RAP Blend)	8/6/2008	2:40 PM	6 NE	0.36	0.331

4.4 Surface Distresses

Surface distresses of each section were recorded following the USACE methods. A distress survey for each section was completed every day in which dust measurements were collected. If dust was being collected on two consecutive days, then only one surface distress survey was performed as the conditions would not drastically change overnight unless thunderstorms passed through during the night. The individual distresses on a given section were used to create an Unsurfaced Road Condition Index (URCI). The URCI gave an overall condition of the roadway. Figure 4.4 summarizes the URCI of the Laramie County test sections throughout the summer of 2008. Figure 4.5 shows the URCI of the Johnson County test sections throughout the summer of 2008.

Notice that a threshold value of 50 was used to determine if a given section was failing or not. By the end of the summer, section S0 in Johnson County was failing due to large amounts of loose aggregate and rutting. Please refer to Appendix B for the complete data set of condition indices and distresses.

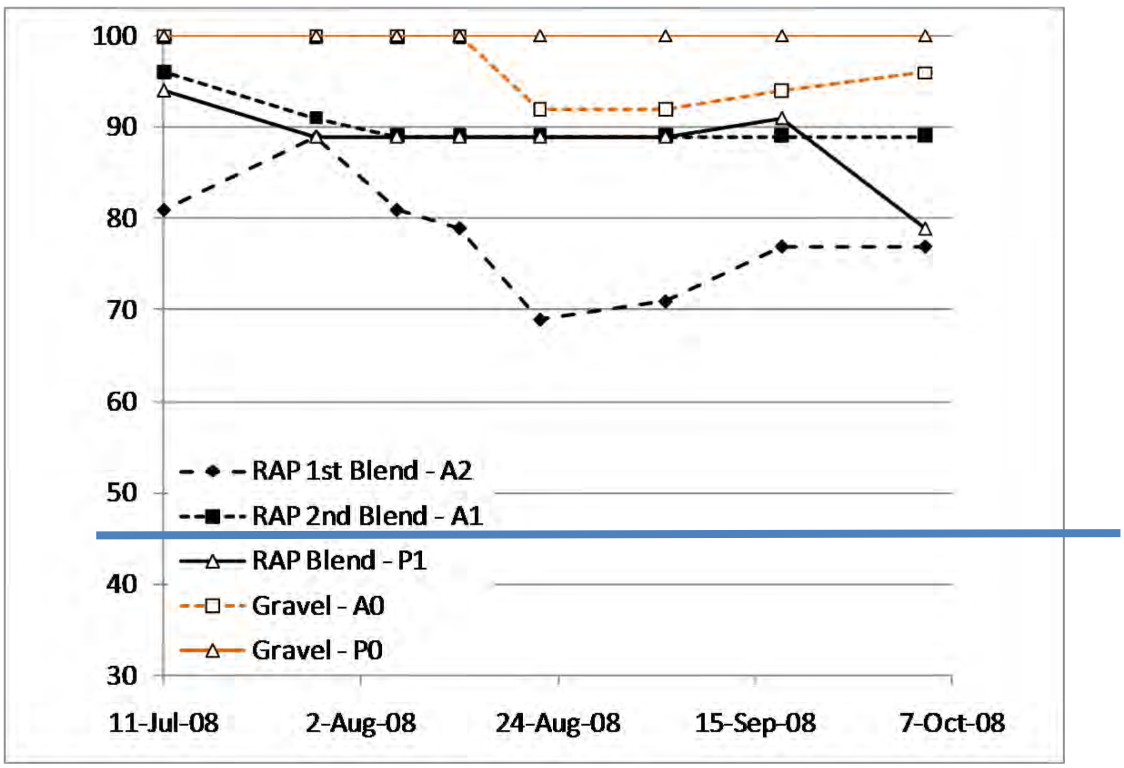

Figure 4.4 Laramie County Overall URCI

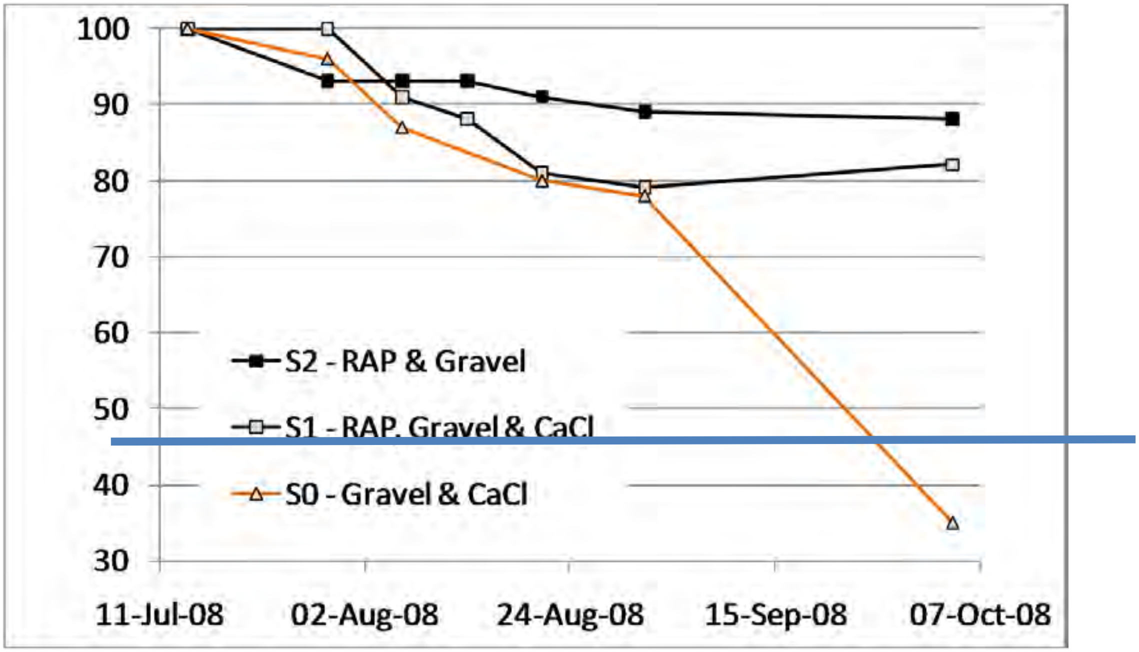

Figure 4.5 Johnson County Overall URCI69

4.5 Traffic Counts

Traffic data was collected on all of the roads used in this study. Traffic volume, speed, and class were collected using road tubes. This data were collected by the individual county's road and bridge department or by the WYT[2] center. Traffic data were collected for at least 10 days to get a representative sample. Tables 4.10 and 4.11 summarize the traffic data for Atlas and Pry Roads in Laramie County. Table 4.12 summarizes the traffic data for Schoonover Road in Johnson County.

The traffic on Atlas and Pry Roads in Laramie County was very similar. Speeds, volumes, and vehicle classifications were essentially the same for both of these roads. Since the difference in traffic is negligible, the test sections on Atlas and Pry Roads can be compared without worrying about the effect of traffic being different on the two roads.

The traffic data in Laramie County are significantly different than the traffic data collected in Johnson County. Traffic volumes and vehicle classifications are highly varied between the two counties. The test sections in Johnson County experienced more traffic volume than the test sections in Laramie County. An average of 25 vehicles per day drove on the test sections in Laramie County and an average of 237 vehicles per day drove on the test sections in Johnson County. Furthermore, the traffic in Johnson County had significantly more trucks compared with the traffic in Laramie County. Schoonover Road in Johnson County experienced 74% trucks compared with an average of 3% on Atlas Road and 12% on Pry Road in Laramie County. The majority of the trucks on Schoonover Road were classed as either 2-Axle Long or 2-Axle 6 Tire. The difference in traffic among the counties would play a role in the condition indices of the test sections within the two counties.

Table 4.10 Laramie County Atlas Road Traffic Data

	Traffic Volume		Vehicle Classification				85th percentile Speed (MPH)	
	Direction 1	Direction 2	Direction 1		Direction 2		Direction 1	Direction 2
	Cars &Trucks	Cars &Trucks	Cars	Trucks	Cars	Trucks	Cars &Trucks	Cars &Trucks
Fri 9/5/2008	23	25	23	0	25	0	52	58
Sat 9/6/2008	21	22	19	2	21	1	54	60
Sun 9/7/2008	26	22	26	0	21	1	56	55
Mon 9/8/2008	22	21	22	0	21	0	59	57
Tue 9/9/2008	34	32	33	1	31	1	54	52
Wed 9/10/2008	20	19	19	1	19	0	53	61
Thu 9/11/2008	28	24	28	0	24	0	53	59
Fri 9/12/2008	21	19	21	0	19	0	50	50
Sat 9/13/2008	26	23	26	0	23	0	51	54
Sun 9/14/2008	26	25	23	3	24	1	55	56
Mon 9/15/2008	32	30	30	2	28	2	55	58
Tue 9/16/2008	34	33	33	1	32	1	55	55
Wed 9/17/2008	23	25	23	0	24	1	56	59
Thu 9/18/2008	37	27	35	2	25	2	51	58
Fri 9/19/2008	26	30	25	1	28	2	55	55
Sat 9/20/2008	26	25	24	2	23	2	54	57
Sun 9/21/2008	26	19	26	0	19	0	54	53
Mon 9/22/2008	25	22	25	0	22	0	51	56
Average	26.4	24.6	25.6	0.8	23.8	0.8	53.8	56.3
	Directional Distribution (%)		Percent of Vehicles (%)					
	52	48	97	3	97	3		
Traffic Counter ID: 20394 Traffic Volumes and Speed on: Atlas124A								

Table 4.11 Laramie County Pry Road Traffic Data

	Traffic Volume		Vehicle Classification				85th percentile Speed (MPH)	
	Direction 1	Direction 2	Direction 1		Direction 2		Direction 1	Direction 2
	Cars &Trucks	Cars &Trucks	Cars	Trucks	Cars	Trucks	Cars &Trucks	Cars &Trucks
Fri 9/5/2008	25	42	23	2	20	22	55	47
Sat 9/6/2008	21	16	19	2	15	1	61	57
Sun 9/7/2008	16	13	16	0	13	0	56	61
Mon 9/8/2008	24	19	22	2	18	1	55	54
Tue 9/9/2008	31	19	30	1	19	0	59	51
Wed 9/10/2008	35	51	31	4	34	17	55	55
Thu 9/11/2008	32	44	32	0	31	13	56	58
Fri 9/12/2008	21	15	21	0	15	0	55	56
Sat 9/13/2008	21	17	20	1	17	0	53	54
Sun 9/14/2008	27	16	27	0	16	0	57	58
Mon 9/15/2008	27	24	26	1	24	0	57	56
Tue 9/16/2008	28	23	26	2	22	1	58	54
Wed 9/17/2008	24	19	21	3	17	2	59	58
Average	25.5	24.5	24.1	1.4	20.1	4.4	56.6	55.3
	Directional Distribution (%)		Percent of Vehicles (%)					
	51	49	94.5	5.5	82	18		
Traffic Counter ID: 20099 Traffic Volumes and Speed on: Pry224								

Table 4.12 Johnson County Schoonover Road Traffic Data

Date	24-Hour Combined Traffic Volume
Tue, 6/10/2008	275
Wed, 6/11/2008	261
Thu, 6/12/2008	240
Fri, 6/13/2008	275
Mon, 6/16/2008	266
Tue, 6/17/2008	270
Wed, 6/18/2008	276
Thu, 6/19/2008	247
Fri, 6/20/2008	151
Mon, 6/23/2008	225
Tue, 6/24/2008	230
Wed, 6/25/2008	264
Thu, 6/26/2008	176
Fri, 6/27/2008	136
Mon, 6/30/2008	262
Average	236.93
Standard Deviation	46.21
85th Percentile Speed (MPH)	51.4
Maximum Speed (MPH)	85.1

Vehicle Classification		
Class	**Count**	**Percent**
Cars	114	2.9%
Pickups	914	23.0%
Trucks	2944	74.1%
Overall ADT	188.0	

Vehicle Classification Breakdown		
Class	**Count**	**Percent**
Cars & Trailer	114	2.9%
2 Axle Long	914	23.0%
Buses	49	1.2%
2 Axle 6 Tire	1857	46.8%
3 Axle Single	301	7.6%
4 Axle Single	9	0.2%
< 5 Axle	285	7.2%
5 Axle Double	337	8.5%
>6 Axle	95	2.4%
<6 Axle Multi	0	0.0%
6 Axle Multi	2	0.1%

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4.6 Section Summary

In this section, the collected field data as well as the laboratory results were presented. Dust, moisture content, wind speed, and wind direction were collected on every test section. The URCI produced from surface distress surveys on each test section was used to evaluate the performance of the test sections throughout the testing period. None of the test sections in Laramie County were considered as failing. One test section in Johnson County, gravel with CaCl, was considered failing by the end of the 2008 summer due to a URCI below 50. Traffic data were also collected on the three roads used in this study. The volumes of traffic between the two counties were significantly different. Schoonover Road in Johnson County experienced much heavier traffic volumes than two roads in Laramie County and it saw 74% trucks.

Samples of the materials used in this research were tested by the WYDOT Materials Testing Laboratory to determine the material characteristics. It was found that the gravel used in Laramie County had much more material passing the #200 (0.075mm) sieve compared with the gravel used in Johnson County. This trend also held true for the RAP blends used in each county. In the following chapter, a statistical analysis on the collected data is presented

5. DATA ANALYSIS

5.1 Introduction

Following the data collection described in the previous chapter, preliminary and statistical analyses were performed on the data. The preliminary analysis involved visually inspecting plots of data to identify relationships that may be present in the data. Dust data were plotted against age, moisture content, and wind speed to detect possible relationships among the variables. These preliminary analyses were performed to gain an understanding of the behavior of data.

Statistical software was used to analyze the collected data. This analysis used statements within the general linear model (GLM) procedures to contrast groups of data. Using the contrast values, it could be determined what group of data was dominating the contrast. This technique allowed for more than one section to be in a given group allowing for comparisons to be made on more than a one-to-one basis. The groupings included sections containing the following characteristics: Laramie County, Johnson County, RAP, no RAP, calcium chloride (CaCl), and no CaCl.

A second statistical analysis was performed where the data was broken down by county as the test sections in both counties were constructed using different techniques. This analysis involved a sectional analysis of the test sections where individual test sections were compared with each other on a one-to-one basis. The test sections were compared using dust, Unsurfaced Road Condition Index (URCI), and surface distress data. Attempts at creating a model for predicting dust loss based on the collected data were made. This chapter describes the preliminary and statistical analyses used to evaluate the collected data. The analyses performed used Microsoft Excel and SAS 9.2 for Windows. The SAS code and results can be found Appendix D.

A general cost comparison analysis was also performed. The goal of this analysis was to evaluate the costs of using RAP and other dust suppressants in gravel roads. Furthermore, this analysis was performed to give agencies an idea of the cost effectiveness of using RAP in gravel roads.

5.2 Preliminary Analysis

Visual inspection of the collected data was performed to detect any relationships found in the data. Dust was plotted against age, moisture content, and wind speed to help understand the behavior of the data. The data was broken down by county and test section to perform this analysis.

5.2.1 Dust vs. Age

One relationship that was desired to analyze data behavior was dust loss versus age. In general, as a test section aged the dust loss decreased. As more dust is lost, there is less dust available to be removed from the section. When all of the dust data from Johnson County is plotted against the age of the test sections, there is a general decline in dust loss with time. The same general decrease holds true for the Laramie County data. Figures 5.1 and 5.2 show the dust versus age plots for Johnson and Laramie Counties, respectively. The decrease in dust with age also holds true for all of the individual sections within the counties. The plots for the individual sections can be found in Appendix A. Although this relationship can be visually seen, further research will be needed to quantitatively define the relationship.

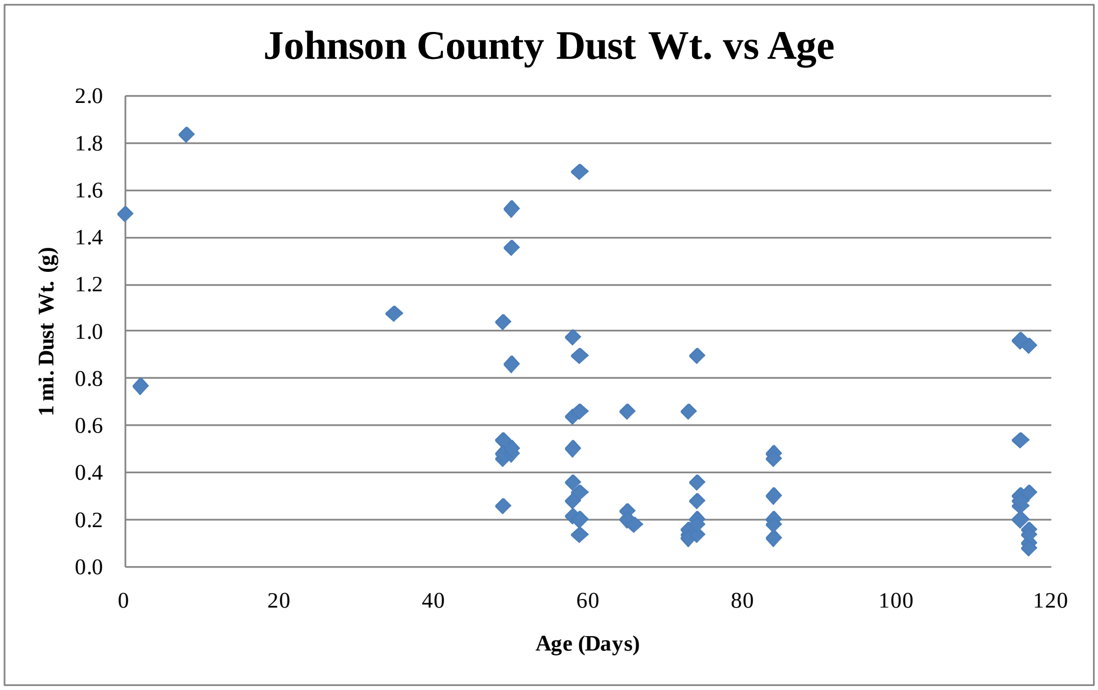

Figure 5.1 Johnson County Dust vs. Age

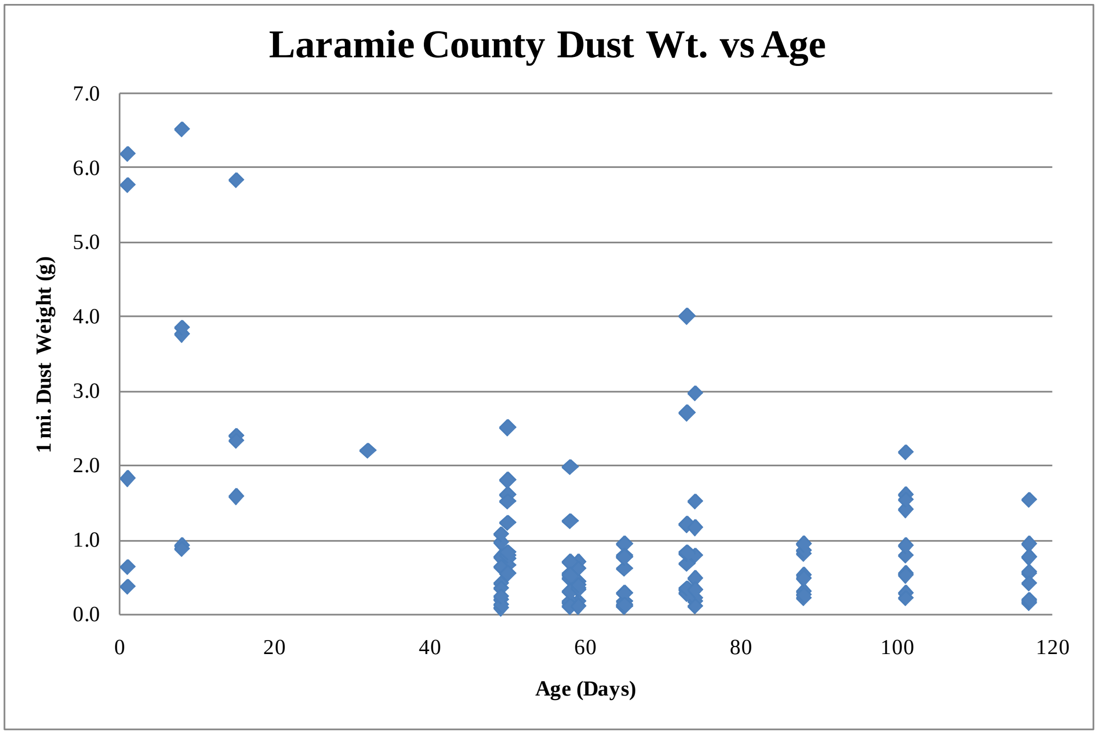

Figure 5.2 Laramie County Dust vs. Age

5.2.2 Dust vs Moisture Content

The dust loss and moisture content relationship was also investigated. It was concluded that no particular relationship between dust loss and moisture content in the individual sections can be established. This is because dust data were not collected when the roadway surface was wet. This resulted in a small range of moisture contents in which dust was collected. Also, within the small range of moisture contents there are no big variations in the collected dust weights. These conclusions hold true for both Johnson and Laramie Counties. Figures 5.3 and 5.4 give examples of dust loss versus moisture content in Johnson and Laramie Counties, respectively. The rest of the plotted data for dust loss versus moisture content can be found in Appendix A.

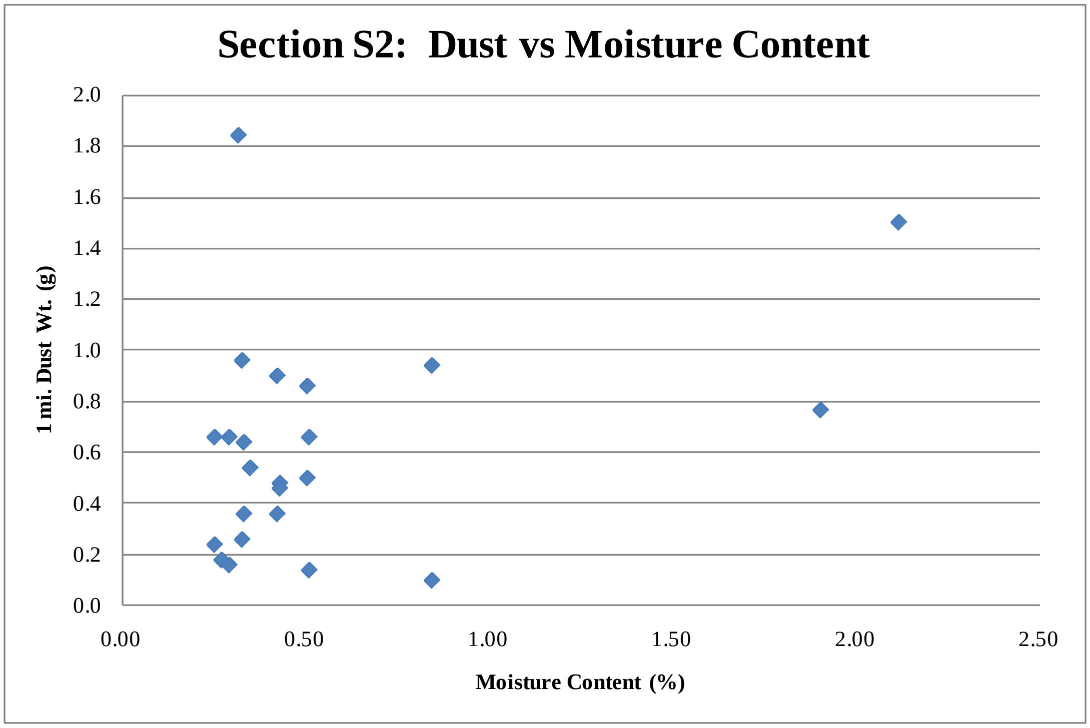

Figure 5.3 Example from Johnson County Dust vs. Moisture Content

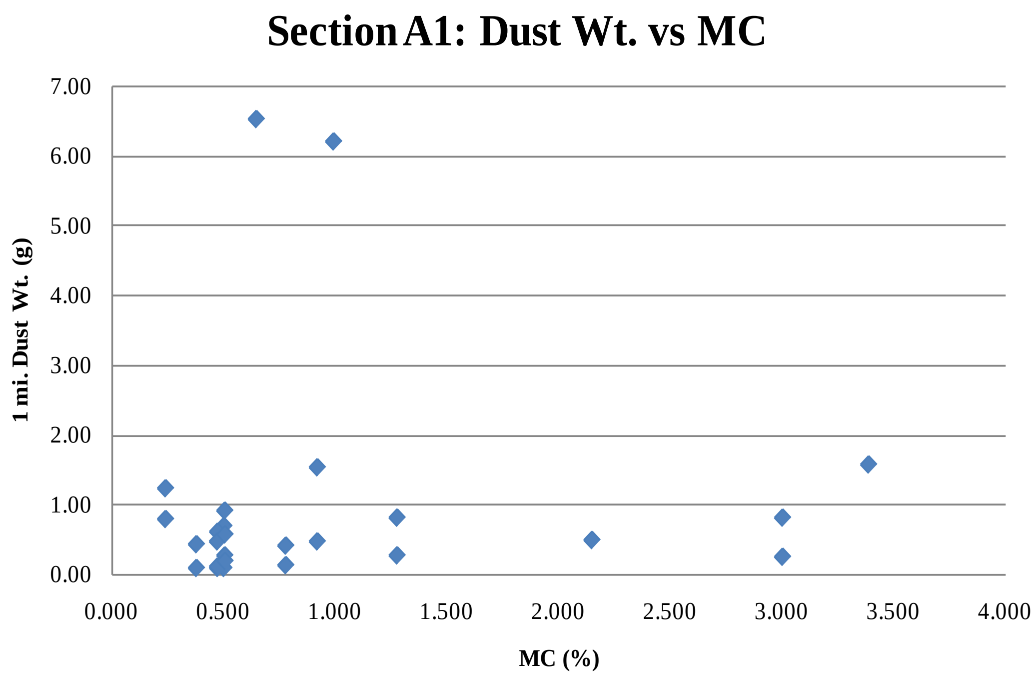

Figure 5.4 Example from Laramie County Dust vs. Moisture Content

5.2.3 Dust vs Wind Speed

The relationship between dust loss and wind speed was also desired. It was suggested from visual inspection that a general trend between dust loss and wind speed could be inferred. The higher the wind speed, the lower the collected dust weight. Examples of this can be seen in Figures 5.5 and 5.6 for Johnson and Laramie Counties, respectively. It should also be noted that the variability in the dust weights is most likely attributed to the wind direction with respect to the direction of travel. That is, a strong headwind would force more dust into the collection box while a strong tailwind would prevent dust from reaching the box. It is suggested that dust collection should not be performed in high winds in order to ensure fair sampling.

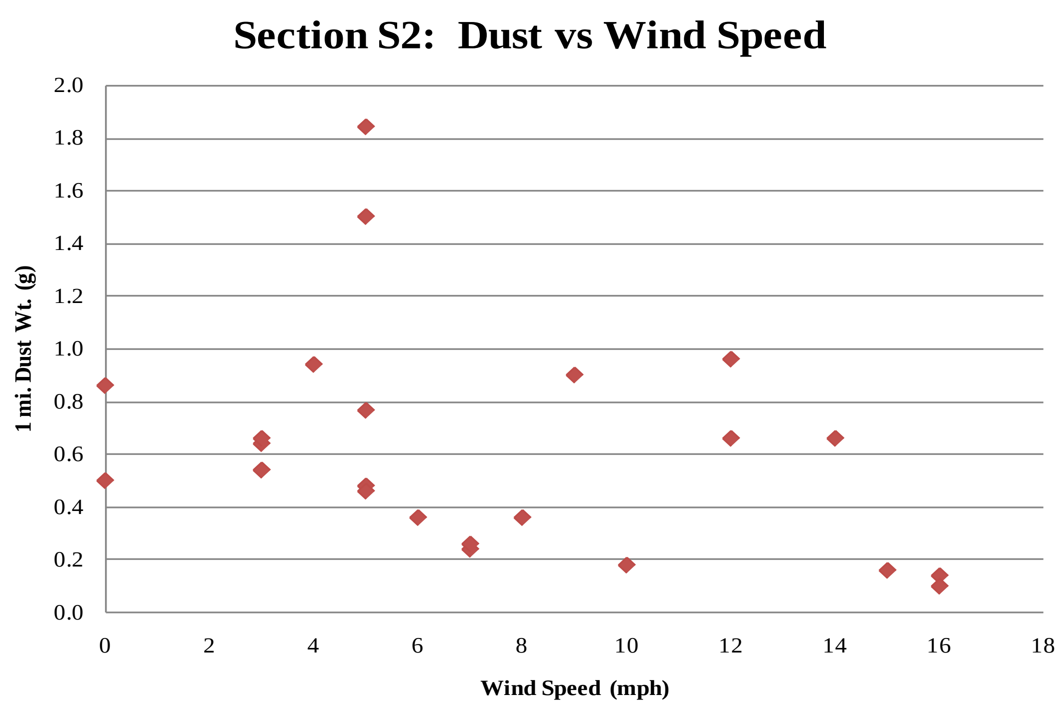

Figure 5.5 Example from Johnson County Dust vs. Wind Speed

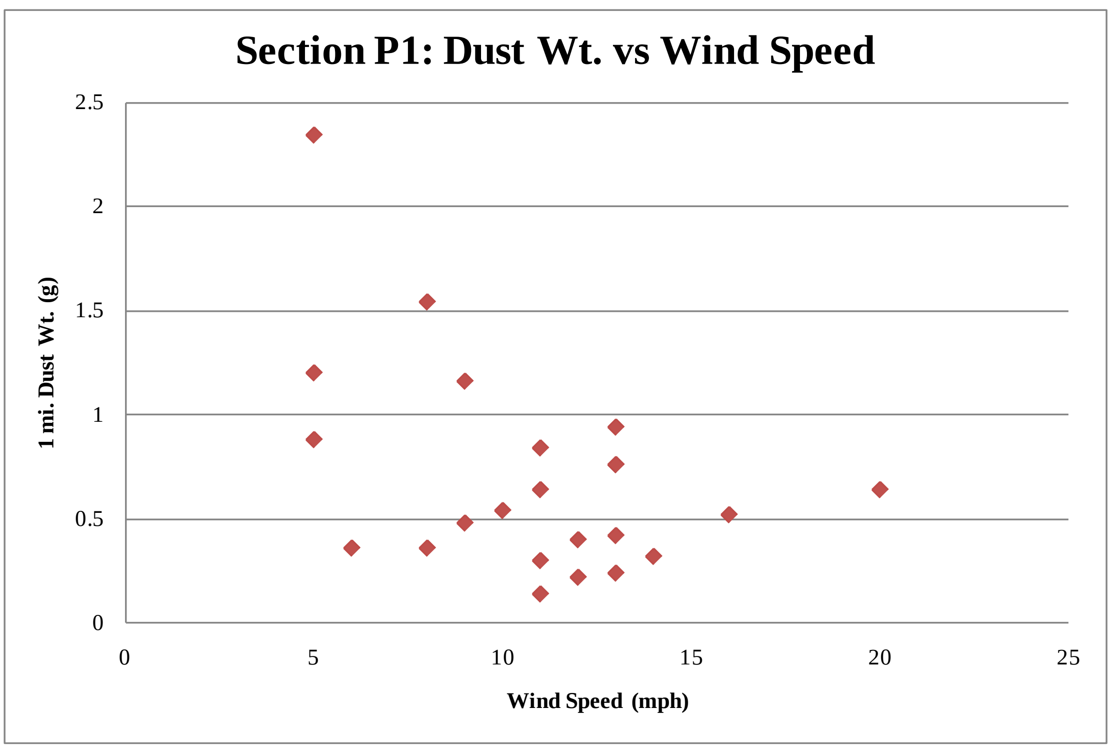

Figure 5.6 Example from Laramie County Dust vs Wind Speed

5.3 Statistical Contrast Analysis

Statistical software was used to analyze the collected data. This analysis used statements within the general linear model (GLM) procedures to contrast groups of data. The contrast values were used to determine what group of data was dominating the contrast. This technique allowed for more than one section to be in a given group, allowing for comparison to be made on more than a one-to-one basis. The groupings included sections containing the following comparisons: Laramie versus Johnson County, RAP versus no RAP, and calcium chloride (CaCl) versus no CaCl.

Contrasts were made on the basis of dust and URCI. All eight sections in the study were used in this analysis. An alpha value of 0.10 was chosen due to the inherent variability of unpaved roads. P-values were measured against the 0.10 value to determine if the groups were significantly different from one another. P-values less than 0.10 were considered significantly different and conclusions could be drawn. A contrast with a p-value greater than 0.10 was said to have no proof of the groups being significantly different and the results would not be considered. All contrasts in this analysis were found to be significantly different, therefore conclusions could be made.

In this analysis, a wind factor was established to help describe the effect of the wind on sampling. The wind speed, wind direction, and the angle in which the wind blew with respect to the roadway were used to establish the wind factor. Each direction of wind was given a degree value based on where it fell on a circle. A circle was broken up into sixteen segments to help describe the wind direction. North was given a value of zero. Moving in the clockwise direction each segment was 22.5 degrees larger than the last. A summary of the wind direction degree values can be found in Figure 5.7.

Wind directions

Abbreviation	wind direction	Degrees
N	North	0°
NNE	NorthNorthEast	22.5°
NE	NorthEast	45°
ENE	EastNorthEast	67.5°
E	East	90°
ESE	EastSouthEast	112.5°
SE	SouthEast	135°
SSE	SouthSouthEast	157.5°
S	South	180°
SSW	SouthSouthwest	202.5°
SW	Southwest	225°
WSW	WestSouthwest	247.5°
W	West	270°
WNW	WestNorthwest	292.5°
NW	Northwest	315°
NNW	NorthNorthwest	337.5°

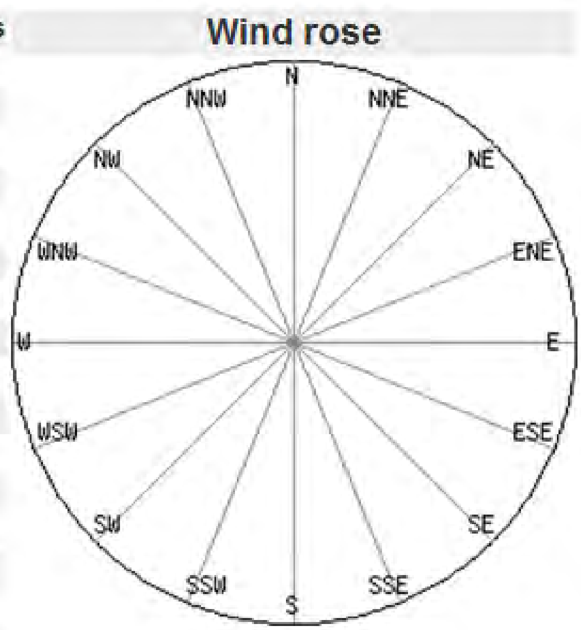

Figure 5.7 Wind Direction and Degree Values

Atlas Road in Laramie County runs east and west. Pry Road in Laramie County runs north and south. Schoonover Road in Johnson County runs NNW and SSE. The angle of the wind direction perpendicular to the bearing of the roads was calculated for each dust weight calculated. This angle was designated as θ (theta). The following equation was used to determine the wind factor.

$$Wind\ Factor = Wind\ Speed * \cos(\theta)$$

Data was collected on each section from both directions of travel. For example, data were collected on Atlas Road driving west and east. The average of the data collected in each direction on any given section was determined. This was done in order to not violate assumptions associated with the variance of populations used in statistical analysis. Therefore, all of the variables used in this analysis were the average of the two collections taken in opposite directions.

The variables available for use in the contrast analysis model included dust, moisture content, age, wind factor, and URCI. A residual analysis of the data was performed. From the residual analysis it was confirmed that the linear model assumptions were met. Therefore, the model was considered to be suitable for the contrast analyses.

5.3.1 Contrast Analysis Based on Dust

A contrast analysis was performed on the basis of dust. The dependent variable used was the log of the average dust weights. The log function was chosen to improve the necessary assumptions of linearity, equal variance, and normality needed to trust the statistical results. The independent variables included the averages of age, moisture content, and the wind factor.

Three contrasts were made using the following parameters: Laramie County versus Johnson County; sections with no RAP versus sections with RAP, and sections with no CaCl versus sections with CaCl. The results of these contrasts can be found in Table 5.1. Since the contrast was based on *X* vs. *Y*, a positive estimate value means that *X* is dominating and a negative estimate value means *Y* is dominating the contrast.

Table 5.1 Log Dust Contrast Results

Parameter	Estimate	Standard Error	t value	p value
Laramie vs. Johnson	1.05741117	0.13723690	7.71	<.0001
noRAP vs. RAP	0.38804705	0.13641207	2.84	0.0056
noCaCl vs. CaCl	1.26457298	0.16427895	7.70	<.0001

From the results found in Table 5.1, it can be seen that there is more dust loss associated with the Laramie County test sections compared with the Johnson County test sections. Sections without RAP produced more dust than those with RAP. Also, sections without CaCl had more dust loss than sections with CaCl. The difference in the two groups was calculated using the following equation:

$$e^{\text{estimate value}} = \left[\frac{\text{dust in } X}{\text{dust in } Y}\right]$$

By using this equation, the amount of difference in the two groups was calculated. It was found that the Laramie County test sections had 288% more dust than the Johnson County test sections. Sections without RAP exhibited 147% more dust than sections utilizing RAP. Finally, sections without CaCl had 354% the amount of dust loss of sections with CaCl.

These results are linked to the laboratory results on the materials used in this research. From the gradations found in Chapter 4, it was found that the test sections in Laramie County exhibited more material passing the #200 sieve than the Johnson County test sections. The gravel and RAP blend used in Laramie County had 23% and 2.2% material passing the #200 (0.075mm) sieve, respectively. In Johnson County, 11.6% of the gravel material and 1.0% of the RAP blend material passed the #200 (0.075mm) sieve. Therefore, more dust was available to be captured in Laramie County. Also, the roadways in the Laramie County were not compacted using a drum roller as they were in Johnson County.

The percentage of RAP blended material passing the #200 (0.075mm) sieve in Laramie County was 20% less than the percentage of gravel material passing the #200 (0.075mm) sieve. In Johnson County, the RAP blend had 10% less material passing the #200 (0.075mm) sieve than gravel. Therefore, any test sections that contained RAP would have less material available for capture as dust. Finally, the use of CaCl significantly reduced the amount of dust loss. This was expected as it is the nature of CaCl to capture moisture from the air surrounding the roadway surface and keep dust size materials from becoming airborne.

5.3.2 Contrast Analysis Based on URCI

A contrast analysis was performed on the basis of the URCI. The dependent variable used was URCI, with dust, age, moisture content, and wind factor being the independent variables. Three contrasts were made using the following parameters: Laramie County versus Johnson County, sections with no RAP versus sections with RAP, and sections with no CaCl versus sections with CaCl. The results of these contrasts can be found in Table 5.2. Since the contrast was based on *X* vs. *Y*, a positive estimate value means that *X* is dominating and a negative estimate value means *Y* is dominating the contrast. The resulting contrast values only indicate which group is dominating the contrast and quantitative comparisons of the two values cannot be adequately developed due to the nature of the URCI being composed of multiple factors that are not necessarily the same in each group.

Table 5.2 URCI Contrast Results

Parameter	Estimate	Standard Error	t Value	p value
Laramie vs. Johnson	5.26596165	1.28732118	4.09	0.0001
noRAP vs. RAP	4.80737817	1.18336694	4.06	0.0001
noCaCl vs. CaCl	8.67047145	1.60173674	5.41	<.0001

Based the results found in Table 5.2, it can be seen that the URCI of the Laramie County test sections had better URCI scores compared with the Johnson County test sections. This is most likely due to a couple of factors. First, the volume of traffic on the Johnson County test sections (237 vpd) was much heavier than the traffic in Laramie County (25 vpd). Also, the number of trucks using the Johnson County test sections (74% trucks) was much more than the trucks using the Laramie County test sections (3-12% trucks). Secondly, CaCl was used on the Johnson County test sections. This presented the opportunity for rutting to occur on the sections with CaCl.

Sections without RAP had better URCI scores compared with sections with RAP. This is most likely due to the RAP sections having more loose aggregate. The amounts of loose aggregate on the RAP sections can be found in the URCI data sheets in Appendix B. This is further described in the following subsections that utilize sectional analysis methods. Sections without CaCl had better URCI scores than sections with CaCl. This is mainly due to the presence of rutting in the CaCl, which is described in more detail in the sectional analysis results in the following subsections.

5.4 Sectional Analysis of the Laramie County Test Sections

A sectional analysis was performed based on the collected data in Laramie County. The analysis consisted of comparing a RAP section to its control counterpart or another RAP section. Comparisons were made based on dust loss, URCI, and surface distresses found in both sections. The analysis was based on subtracting the values for a RAP section from those of the corresponding control/RAP section. The data were sorted by county, date, and direction of travel in order to make a fair comparison. Environmental elements such as wind speed, wind direction, and moisture content were not included in the analysis.

The comparisons based on dust loss, URCI, and surface distresses each contained: (1) a mean difference between the two sections being compared and a corresponding standard deviation, (2) a mean percentage difference between the two sections being compared and a corresponding percent standard deviation, and (3) a paired T-test p-value for the two sections being compared. An alpha level of 0.10 was chosen due to inherent variability of unpaved roads.

The p-values were measured against the 0.10 alpha level to see if the two sections' samples were significantly different. Any p-values less than 0.10 were considered significantly different and conclusions could be drawn. A set of sections with a p-value greater than 0.10 was said to have no proof of significant difference and were not considered.

5.4.1 Sectional Analysis Based on Dust

The collected dust data on each section in Laramie County were analyzed using the sectional data analysis methods previously mentioned. Table 5.3 summarizes the analysis of the dust data for Laramie County. From Table 5.3 it can be seen that the control section on Pry Road in Laramie County had 41% more dust than the section with 1.5 inches of RAP. The control section on Atlas Road had 20% more dust than the section with 1.5 inches of RAP. Therefore, the RAP sections were producing significantly less dust loss in Laramie County. This is due to the control sections having more bonding because more gravel material is passing the #200 (0.075mm) sieve compared with the RAP sections. It should also be noted that there was no difference between the control section and the section with 2.5 inches of RAP in terms of dust. This is most likely due to poor construction on section A2 and less likely the material itself as this section was the first section to be blended. Section A2 was re-blended shortly after initial construction.

Table 5.3 Laramie County Sectional Data Analysis Results Based on Dust

	Atlas Road - A2 (2 1/2" RAP) vs Atlas Road - A0 (100 % Gravel)	**Atlas Road - A1 (1 1/2" RAP) vs Atlas Road - A0 (100 % Gravel)**	**Pry Road - P1 (1 1/2" RAP) vs Pry Road - P0 (100 % Gravel)**
Analysis based on :	**A0 - A2**	**A0 - A1**	**P0 - P1**
DUST MEAN DIFFERENCE (g)	**0.18**	**0.27**	**0.77**
DUST DIFFERENCE STD. DEV. (g)	**0.39**	**0.52**	**0.92**
DUST MEAN % DIFFERENCE	**0%**	**20%**	**41%**
DUST % DIFFERENCE STD. DEV.	**51%**	**40%**	**33%**
DUST T-TEST P-VALUE	**7E-02**	**3E-02**	**4E-03**

5.4.2 Sectional Analysis Based on URCI

The overall URCI data on each section in Laramie County was analyzed using the sectional data analysis methods previously mentioned. Table 5.4 summarizes the analysis of the URCI data for Laramie County. From Table 5.4 it can be seen that the control sections in Laramie County are performing slightly better than the RAP sections. The control section on Atlas Road compared with the 1.5 inch and 2.5 inch RAP sections had 16% and 5% better URCI values, respectively. On Pry Road, the control section had URCI values that were 9% better than those of the 1.5 inch RAP section. The reason for this is found within the comparison of the surface distresses, particularly the loose aggregate, which is discussed in the next subsection.

Table 5.4 Laramie County Sectional Data Analysis Results Based on URCI

	Atlas Road - A2 (2 1/2" RAP) vs Atlas Road - A0 (100 % Gravel)	Atlas Road - A1 (1 1/2" RAP) vs Atlas Road - A0 (100 % Gravel)	Pry Road - P1 (1 1/2" RAP) vs Pry Road - P0 (100 % Gravel)
Analysis based on :	**A0 - A2**	**A0 - A1**	**P0 - P1**
URCI MEAN DIFFERENCE	**15.44**	**5.33**	**9.33**
URCI DIFFERENCE STD. DEV.	**2.19**	**3.54**	**3.00**
URCI MEAN % DIFFERENCE	**16%**	**5%**	**9%**
URCI % DIFFERENCE STD. DEV.	**2%**	**4%**	**3%**
URCI T-TEST P-VALUE	**3E-08**	**2E-03**	**1E-05**

5.4.3 Sectional Analysis Based on Surface Distresses

The surface distress data on each section in Laramie County were analyzed using the sectional data analysis methods previously mentioned. Table 5.5 summarizes the analysis of the distress data for Laramie County. Loose aggregate was the only surface distress that could be compared in this analysis. This is because no other sections in Laramie County, except for the 2.5 inch RAP section on Atlas Road, displayed any other surface distresses.

From Table 5.5 it can be seen that the RAP sections in Laramie County tend to have more loose aggregate. The 2.5 inch RAP section on Atlas Road had 132% more loose aggregate than the control section on Atlas Road that it was being compared with. When the control sections on Atlas and Pry Roads were compared with the 1.5 inch RAP sections on each road, there was 81% and 100% more loose aggregate, respectively, on the 1.5 inch RAP sections on Atlas and Pry Roads. This is an expected characteristic when using RAP in the road surface as the larger aggregates will tend to work to the outside of the roadway.

Table 5.5 Laramie County Sectional Data Analysis Results Based on Loose Aggregate

	Atlas Road - A2 (2 1/2" RAP) vs Atlas Road - A0 (100 % Gravel)	Atlas Road - A1 (1 1/2" RAP) vs Atlas Road - A0 (100 % Gravel)	Pry Road - P1 (1 1/2" RAP) vs Pry Road - P0 (100 % Gravel)
Analysis based on :	A0 - A2	A0 - A1	P0 - P1
LOOSE AGG. MEAN DIFFERENCE	-11.44	-5.89	-9.67
LOOSE AGG. DIFFERENCE STD. DEV.	3.09	3.86	2.18
LOOSE AGG. MEAN % DIFFERENCE	-132%	-81%	-100%
LOOSE AGG. % DIFFERENCE STD. DEV.	54%	51%	0%
LOOSE AGG. T- TEST P-VALUE	4E-06	2E-03	1E-06

5.5 Sectional Analysis of the Johnson County Test Sections

A sectional data analysis was performed based on the collected data in Johnson County. The analysis consisted of comparing the three test sections on Schoonover Road. Comparisons were made based on dust loss, URCI, and surface distresses found in both sections. The analysis was based on subtracting the values for one section from those of the comparative section. The data were sorted by date and direction of travel in order to make a fair comparison. Environmental elements such as wind speed, wind direction, and moisture content were not included in the analysis.

The comparisons based on dust loss, URCI, and surface distresses each contained: (1) a mean difference between the two sections being compared and a corresponding standard deviation, (2) a mean percentage difference between the two sections being compared and a corresponding percent standard deviation, and (3) a paired T-test p-value for the two sections being compared. An alpha level of 0.10 was chosen due to inherent variability of unpaved roads.

The p-values were measured against the 0.10 alpha level to see if the two sections' samples were significantly different. Any p-values less than 0.10 were considered significantly different and conclusions could be drawn. A set of sections with a p-value greater than 0.10 was said to have no proof of significant difference and were not considered.

5.5.1 Sectional Analysis Based on Dust

The collected dust data on each section in Johnson County were analyzed using the sectional data analysis methods previously mentioned. Table 5.6 summarizes the analysis of the dust data for Johnson County. From Table 5.6 it can be seen that the RAP blend with CaCl performed much better than the gravel with CaCl in terms of dust. The control section had nearly 40% more dust than the RAP section. This is most likely due to the control section having greater amounts of material passing the #200 (0.075mm) sieve compared with the RAP sections. When the RAP blend with CaCl is compared with the RAP blend without CaCl, the RAP blend without CaCl had 42% more dust. This result is typical as it is the nature of roadways with CaCl to exhibit less dust loss than those without CaCl. Results could not be drawn from the RAP blend compared with the gravel with CaCl because the p-value of 0.70 is greater than the alpha value of 0.10, which suggests that the two sections are not significantly different in terms of dust.

Table 5.6 Johnson County Sectional Data Analysis Results Based on Dust

	S1 (RAP Blend w/ CaCl) vs S0 (Gravel w/ CaCl)	S2 (RAP Blend) vs S0 (Gravel w/ CaCl)	S1 (RAP Blend w/ CaCl) vs S2 (RAP Blend)
Analysis based on :	**S0 - S1**	**S0 - S2**	**S2 - S1**
DUST MEAN DIFFERENCE (g)	**0.35**	**0.07**	**0.28**
DUST DIFFERENCE STD. DEV. (g)	**0.42**	**0.51**	**0.26**
DUST MEAN % DIFFERENCE	**40%**	**-50%**	**42%**
DUST % DIFFERENCE STD. DEV.	**33%**	**124%**	**32%**
DUST T-TEST P-VALUE	**3E-02**	**7E-01**	**7E-05**

5.5.2 Sectional Analysis Based on URCI

The overall URCI data on each section in Johnson County were analyzed using the sectional data analysis methods previously mentioned. Table 5.7 summarizes the analysis of the URCI data for Johnson County. From Table 5.7 it can be seen that there was no significant difference in the Johnson County sections in terms of URCI due to the p-values being greater than 0.10. But there are specific findings for individual distresses as seen in the next subsection.

Table 5.7 Johnson County Sectional Data Analysis Results Based on URCI

	S1 (RAP Blend w/ CaCl) vs S0 (Gravel w/ CaCl)	S2 (RAP Blend) vs S0 (Gravel w/ CaCl)	S1 (RAP Blend w/ CaCl) vs S2 (RAP Blend)
Analysis based on :	**S0 - S1**	**S0 - S2**	**S2 - S1**
URCI MEAN DIFFERENCE	**-4.83**	**-6.67**	**1.83**
URCI DIFFERENCE STD. DEV.	**8.98**	**8.82**	**4.26**
URCI MEAN % DIFFERENCE	**-7%**	**-9%**	**2%**
URCI % DIFFERENCE STD. DEV.	**14%**	**14%**	**5%**
URCI T-TEST P-VALUE	**2E-01**	**1.2E-01**	**3E-01**

5.5.3 Sectional Analysis Based on Surface Distresses

The surface distress data on each section in Johnson County was analyzed using the sectional data analysis methods previously mentioned. Table 5.8 summarizes the analysis of the distress data for Johnson County. From Table 5.8 it can be seen that rutting and loose aggregate had significant findings. The S_0-S_2 set has no viable comparison for loose aggregate due to a p-value greater than 0.10. The gravel with CaCl section showed almost 26% more loose aggregate than the RAP blend with CaCl section. The RAP blend section also showed 39.5% more loose aggregate than the RAP blend with CaCl section. In terms of rutting, the RAP blend with CaCl showed 67% more rutting than the RAP blend by itself. The gravel with CaCl showed 83% more rutting than the RAP blend without CaCl. This is not surprising due to the nature of CaCl and its effect on the moisture content of the road surface.

Table 5.8 Johnson County Sectional Data Analysis Results Based on Surface Distresses

	S1 (RAP Blend w/ CaCl) vs S0 (Gravel w/ CaCl)	S2 (RAP Blend) vs S0 (Gravel w/ CaCl)	S1 (RAP Blend w/ CaCl) vs S2 (RAP Blend)
Analysis based on :	**S0 - S1**	**S0 - S2**	**S2 - S1**
LOOSE AGG. MEAN DIFFERENCE	**2.50**	**-0.67**	**3.17**
LOOSE AGG. DIFFERENCE STD.	**2.26**	**3.14**	**2.48**
LOOSE AGG. MEAN % DIFFERENCE	**26%**	**-12%**	**39%**
LOOSE AGG. % DIFFERENCE STD.	**27%**	**44%**	**38%**
LOOSE AGG. T-TEST P-VALUE	**4E-02**	**6E-01**	**3E-02**
RUT MEAN DIFFERENCE	**3.00**	**9.67**	**-6.67**
RUT DIFFERENCE STD. DEV.	**8.65**	**10.21**	**5.50**
RUT MEAN % DIFFERENCE	**18%**	**83%**	**-67%**
RUT % DIFFERENCE STD.	**56%**	**41%**	**52%**
RUT T-TEST P-VALUE	**4E-01**	**7E-02**	**3E-02**

5.6 Cost Comparison Analysis

A general cost analysis was performed to evaluate the cost effectiveness of utilizing RAP in gravel roads. This analysis only takes into account material costs and does not account for construction, maintenance, labor, or user cost. It is suggested that these costs should be collected for Phase II of this project in order to adequately develop a benefit-cost analysis.

The main component of a gravel road is the aggregate. The 2009 WYDOT weighted average price for crusher run aggregate was $6.90/ton. A density of 150 pcf was assumed for the crusher run aggregate. Additional cost on a gravel road is the cost of dust suppressants. For this analysis, Magnesium Chloride (MgCl) was used as this product will be utilized in Phase II of this project. As quoted by the Desert Mountain Corporation, the cost to deliver and apply MgCl is $0.53/gallon with an application rate of 0.5 gallons/yd^2. Also, the 2009 WYDOT weighted average price for RAP was $12.77/yd^3. A density value of 140 pcf was assumed for the RAP. Therefore, the cost of RAP was calculated to be $6.75/ton.

The basic design of Phase II of this project has developed one-mile test sections that will consist of 6 inches of RAP or aggregate blended with three inches of native soils. The width of the roadway is 27 feet. This data were utilized to perform the cost comparison. The comparison made was between the material cost of a one-mile RAP blended section and a one-mile section of crusher run aggregate with MgCl.

To cover a roadway that is 27 feet wide with 6 inches of material for one mile will take 71,280 feet^3 of material. It would take 4,990 tons of RAP or 5,346 tons of crusher run aggregate to cover the one-mile roadway at a depth of 6 inches. Therefore, the material cost for the RAP is $33,683.50. The material cost for the aggregate is $36,887.40. A one-mile long road that is 27 feet wide has 142,560 square yards in it. A total of 71,280 gallons of MgCl would be needed to cover the road at a delivery and application cost of $37,778.40. Therefore, the total cost for the RAP section is $33,683.50, and the total cost of the aggregate with the MgCl section is $74,665.80. If MgCl was added to the RAP section, the total cost would be $71,460.90.

In terms of cost effectiveness, this general materials cost comparison shows that RAP is a cost effective material for use in gravel roads; and, as prior analyses show, RAP blends reduce dust loss. These are only general comparisons, and it is suggested for Phase II of this project to confirm this analysis. Initial construction and material costs need to collected. Application costs associated with dust suppressants as well as long-term maintenance costs will also be needed to perform the actual cost analysis.

5.7 Section Summary

Multiple analyses were performed on the collected data from the test sections. These analyses included a preliminary analysis where visual inspection of the collected data was performed to detect any relationships found in the data. Dust was plotted against age, moisture content, and wind speed to help understand the behavior of the data.

From the preliminary analysis it appears that dust loss decreased with age. When dust loss was compared with moisture content, it was implied that moisture content did not have any effect on dust loss at low moisture contents. It was implied from the dust loss and wind speed comparison that dust measurements were affected by wind speed, and collection should not be attempted during high winds in order to ensure fair data collection.

A contrast analysis was also performed on the collected data. In this analysis, groups of data were compared with one another. Contrasts were made on the basis of dust loss as well as URCI. Three contrasts for dust loss and three contrasts for URCI were made using the following parameters: Laramie County versus Johnson County, sections with no RAP versus sections with RAP, and sections with no CaCl versus sections with CaCl.

The contrast analysis based on dust found that the Laramie County test sections had 288% more dust than the Johnson County test sections. Sections without RAP produced 147% more dust than those with RAP. Test sections without CaCl exhibited 354% more dust than sections with CaCl. The reason for these large differences in dust can be found in the materials used within each section with particular emphasis on the percentage of material passing the #200 sieve.

The contrast analysis based on URCI values found that the Laramie County test sections had higher URCI scores compared with the Johnson County test sections. Sections without RAP were found to have higher scores than those with RAP, mostly due to larger amounts of loose aggregate on the RAP sections. Test sections without CaCl were found to have higher URCI scores than sections with CaCl due to the rutting present in the sections utilizing CaCl.

Finally, a sectional statistical analysis was performed on the collected data from the test sections. The purpose of this analysis was to compare the test sections within a given county based on dust, URCI, and surface distresses. The analysis was based on subtracting the values for a RAP section from those of the comparative section.

The sectional analysis performed on the dust data found that the RAP sections in Laramie County had significantly less dust loss than the control sections. In Johnson County, the RAP blend with CaCl performed much better than the gravel with CaCl in terms of dust. When CaCl was not used with the RAP blend section, the gravel with CaCl had less dust loss. When the RAP blend with CaCl was compared with the RAP blend without CaCl, the RAP blend without CaCl created 42% more dust.

The sectional analysis performed on the basis of URCI found that the gravel control sections in Laramie County performed slightly better than the RAP sections. The result from the analysis performed on the Johnson County URCI data revealed no significant difference in the three sections on Schoonover Road. This was due to the resulting p-values being larger than the set value of 0.10.

The sectional analysis performed on the surface distress found that the RAP sections in Laramie County experienced more loose aggregate than the RAP sections. In Johnson County, the RAP blend with CaCl had the least amount of loose aggregate followed by gravel with CaCl. The RAP blend without CaCl had the most loose aggregate. In terms of rutting, the sections with CaCl showed more rutting. The gravel with CaCl exhibited the worst rutting of the three sections.

A general cost analysis showed that RAP is a cost effective material for use in gravel roads. It is suggested that Phase II of this project collect construction and maintenance cost data in order to perform a thorough cost analysis of the actual test sections and confirm that RAP is a cost effective material in gravel roads.

6. CONCLUSIONS AND RECOMMENDATIONS

6.1 Summary

This research project utilized field and laboratory evaluations to study the performance of using Recycled Asphalt Pavement (RAP) in gravel roads by focusing on its ability to reduce dust loss and maintain roadway stability. The field evaluations involved observing eight test sections constructed in two Wyoming counties. Dust collection was accomplished using the Colorado State University Dustometer. Surface distresses were monitored following methods developed by the United States Army Corps of Engineers. Conditions related to wind were collected using a handheld wind vane and digital compass. Roadway moisture content was determined from surface samples. Laboratory evaluations involved material testing performed by WYDOT. All of this data were collected in a database to allow for statistical analyses to be performed in order to evaluate the effectiveness of RAP in gravel roads.

6.2 Conclusions

From the preliminary analysis of the collected data it was observed that dust loss decreased with age. It was also concluded that dust collection should not be taken when wind speeds are high. Dust measurements were taken when the roadway was dry and the moisture content was low. Therefore, at low moisture contents it was determined that moisture content did not appear to affect dust loss.

From the contrast analysis based on dust, sections without RAP generated 147% more dust loss than sections with RAP. The asphalt within the RAP provided better binding for the materials. Test sections without CaCl generated 354% more dust than sections with CaCl. The amount of dust loss in the Laramie County test sections was greater than those in Johnson County by 288% because the materials used in Laramie County had significantly higher percentages of material passing the #200 (0.075mm) sieve.

From the contrast analysis based on URCI, the URCI values in Laramie County were better than the URCI values in Johnson County due to the differences in traffic volumes, particularly when comparing truck traffic (3-12% versus 74% trucks). Sections without RAP had URCI values that were better than sections with RAP due to larger amounts of loose aggregate associated with RAP sections. Sections without CaCl had URCI values that were better than sections with CaCl due to the rutting associated with the use of CaCl. Conclusions drawn from sectional analyses of the data are broken down by county and found in the following two subsections.

From the general cost analysis it was observed that RAP is a cost effective material for use in gravel roads. It is suggested that Phase II of this project collect construction and maintenance cost data in order to perform a thorough cost analysis of the actual test sections and confirm that RAP is a cost effective material in gravel roads.

6.2.1 Laramie County Conclusions

Based on the observations and testing performed on the Laramie County test sections, the following conclusions were drawn:

1. The use of RAP in gravel roads reduced dust loss from 0 to 41%.
2. Overall road serviceability, based on the URCI, was slightly better for the 100% gravel sections. This was due to more loose aggregate seen on the RAP sections.

3. The sections with RAP exhibited significantly more amounts of loose aggregate than the 100% gravel sections.

4. The construction technique blending the RAP and gravel on site by means of a blade led to segregation of the material, resulting in large amount of loose aggregate.

5. Loose aggregate was the main surface distress that was apparent in the Laramie County test sections, especially in the RAP sections.

6. The overall conclusion was that RAP significantly reduced dust loss with no improvement in road condition.

6.2.1 Johnson County Conclusions

Based on the observations and testing performed on the Johnson County test sections, the following conclusions were drawn:

1. The RAP blend section and the gravel with CaCl section were not significantly different in terms of dust, URCI, or loose aggregate.

2. There was no statistical significant difference in the URCI among the three test sections. That is, the RAP sections did not make any improvements in the overall serviceability of the roadway compared with the control section.

3. The gravel with CaCl section showed more loose aggregate than the RAP blend with CaCl section. The RAP blend section without CaCl displayed more loose aggregate than the RAP blend with CaCl. The use of CaCl helped in stabilizing the road surface and reducing the amount of loose aggregate.

4. The sections with CaCl had more rutting than the section without CaCl.

5. The use of RAP in the roadway reduced dust loss. RAP with CaCl reduced dust loss even more.

6. The overall conclusion was that RAP significantly reduced dust loss with no adverse effects to the road serviceability. In addition, using CaCl with the RAP blend further reduced dust loss.

6.3 Recommendations to Agencies

This project thoroughly investigated the use of RAP in gravel roads in two Wyoming counties. From this investigation it has been concluded that the use of RAP is an effective tool for reducing dust loss without compromising road serviceability. For any agency that has a desire to reduce the amount of dust loss on their gravel roads, it is suggested that they follow these recommendations:

1. Blend RAP into the existing gravel road surface or blend RAP with virgin aggregate in a pugmill and place on the existing unsurfaced road to reduce dust loss. If applicable, RAP and gravel should be blended in a pugmill rather than in place to avoid segregation of materials from blade mixing.

2. Compact the RAP blend with a roller if at all possible. This will help in maintaining the long-term road serviceability.

3. Combine CaCl with the RAP blend to further reduce dust loss as well as reduce loose aggregate.

4. Attention should be directed to traffic volumes as there are trade-offs between using RAP and CaCl in gravel roads. Reduced dust loss is most likely more important than minor amounts of loose aggregate and rutting.

5. Attention should be directed to the initial gradations of the materials being used in order to help reduce loss and provide adequate binding. Materials with large amounts of fines (>15% passing the #200 [0.075 mm] sieve) will have more dust available to be lost.

6.4 Recommendations for Phase II

1. Additional field evaluations should be performed to determine the optimum design and construction technique of incorporating RAP into gravel roads.

2. Dust measurements should not be performed on test sections when wind speeds are high and/or when the roadway is wet.

3. Further research should be performed to quantitatively describe the effects of the wind on dust loss. This should be done by developing laboratory techniques to analyze the relationship between dust and wind

4. Laboratory tests should be developed to help correlate field data to lab data. The test(s) should simulate field data in order to make sound statistical analyses. Once verified, the test(s) could be used to make conclusions about a material's dust loss and serviceability.

5. Further research should be performed to study the effects of traffic, especially trucks, on the performance of gravel roads using RAP and other dust suppressants.

6. This research project has determined that RAP used in gravel roads reduces dust loss without adversely affecting road serviceability. Given the benefits that may be utilized by using RAP, further investigations into its use are justified.

7. Construction and maintenance cost data should be collected in order to perform a thorough cost analysis of the actual test sections and confirm that RAP is a cost effective material in gravel roads.

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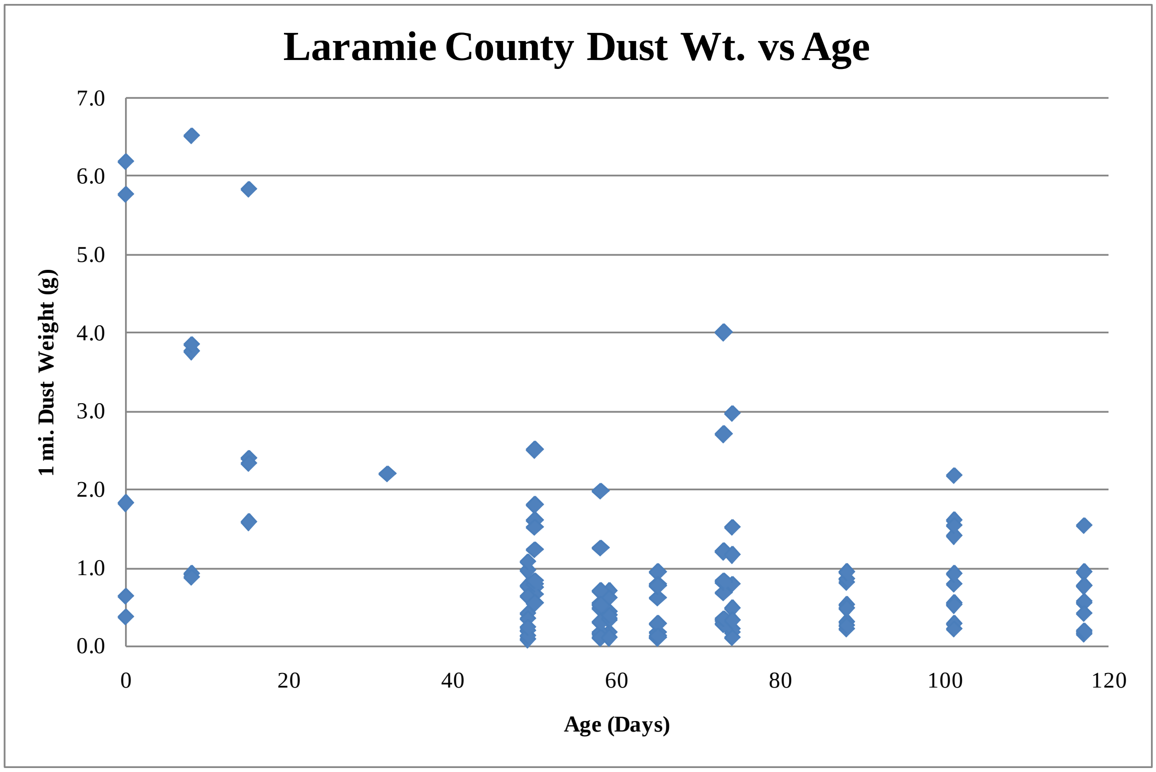
APPENDIX A

DUST COLLECTION, MOISTURE CONTENT, AND WIND DATA

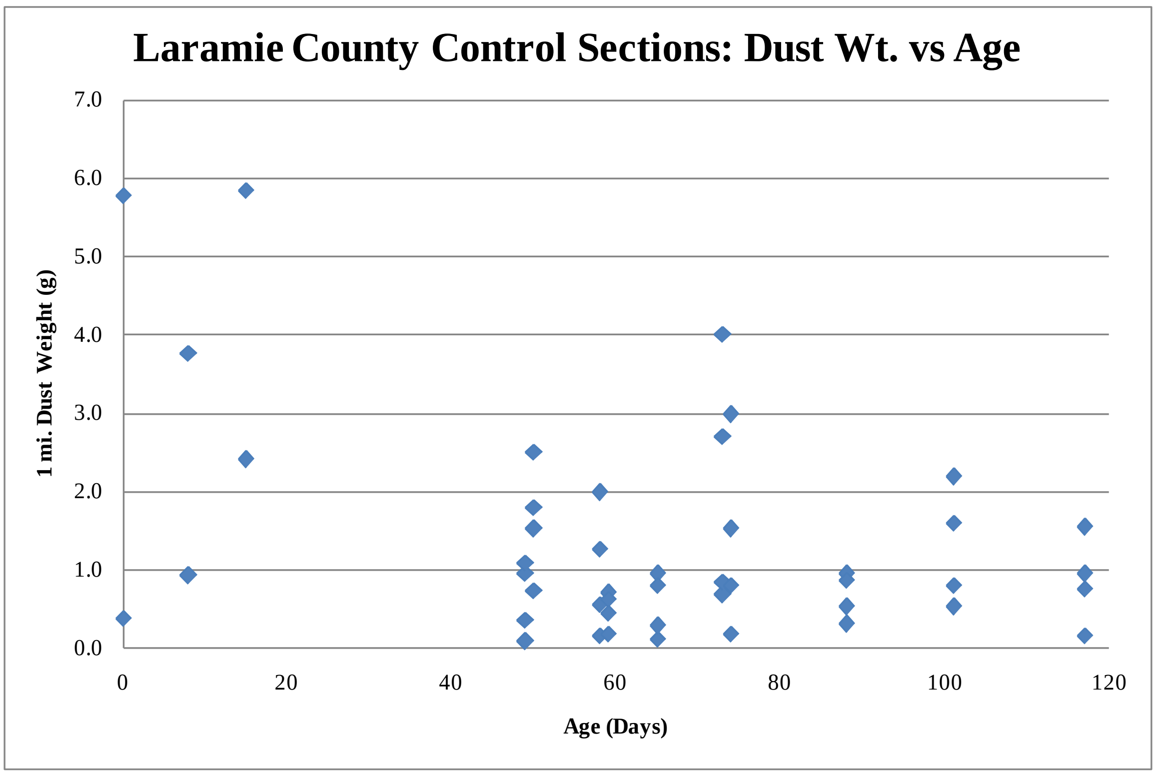
Laramie County Dust, Moisture, and Wind Data						
#	Test Section	Date of Sample	Time of Sample	Wind (mph)	1 mi. Dust Wt. (g)	Moisture Content (%)
1	Atlas Road - A2 (2 1/2" RAP)	6/9/2008	7:55 AM	20 W	1.82	2.044
2	Atlas Road - A1 (1 1/2" RAP)	6/9/2008	8:10 AM	20 W	6.20	0.991
3	Atlas Road - A0 (100% Gravel)	6/9/2008	8:25 AM	20 W	5.78	2.591
4	Pry Road - P1 (1 1/2" RAP)	6/9/2008	8:30 AM	20 W	0.64	2.105
5	Pry Road - P0 (100% Gravel)	6/9/2008	8:35 AM	20 W	0.38	2.549
6	Atlas Road - A2 (2 1/2" RAP)	6/17/2008	7:25 AM	10 W	3.86	0.477
7	Atlas Road - A1 (1 1/2" RAP)	6/17/2008	7:30 AM	10 W	6.52	0.645
8	Atlas Road - A0 (100% Gravel)	6/17/2008	7:40 AM	10 W	3.76	1.029
9	Pry Road - P1 (1 1/2" RAP)	6/17/2008	7:45 AM	10 W	0.88	0.767
10	Pry Road - P0 (100% Gravel)	6/17/2008	7:50 AM	10 W	0.92	1.314
11	Atlas Road - A2 (2 1/2" RAP)	6/24/2008	7:10 AM	10 WNW	2.40	6.362
12	Atlas Road - A1 (1 1/2" RAP)	6/24/2008	7:20 AM	10 WNW	1.58	3.385
13	Atlas Road - A0 (100% Gravel)	6/24/2008	7:30 AM	10 WNW	2.40	5.044
14	Pry Road - P1 (1 1/2" RAP)	6/24/2008	7:35 AM	10 WNW	2.34	4.936
15	Pry Road - P0 (100% Gravel)	6/24/2008	7:40 AM	10 WNW	5.84	5.523
16	Atlas Road - A2 (2 1/2" RAP)	7/11/2008	7:40 AM	15 W	2.20	0.736
17	Atlas Road - A2 (2 1/2" RAP)	7/28/2008	8:45 AM	16 WNW	0.76	0.662
18	Atlas Road - A1 (1 1/2" RAP)	7/28/2008	8:40 AM	20 W	0.42	0.777
19	Atlas Road - A0 (100% Gravel)	7/28/2008	8:30 AM	20 WNW	0.96	1.193
20	Pry Road - P1 (1 1/2" RAP)	7/28/2008	9:15 AM	11 WNW	0.64	0.605
21	Pry Road - P0 (100% Gravel)	7/28/2008	9:05 AM	12 WNW	1.08	1.185
22	Atlas Road - A2 (2 1/2" RAP)	7/28/2008	7:30 AM	11 W	0.20	0.662
23	Atlas Road - A1 (1 1/2" RAP)	7/28/2008	7:50 AM	10 W	0.14	0.777
24	Atlas Road - A0 (100% Gravel)	7/28/2008	8:10 AM	17 WNW	0.08	1.193
25	Pry Road - P1 (1 1/2" RAP)	7/28/2008	9:30 AM	13 WNW	0.24	0.605
26	Pry Road - P0 (100% Gravel)	7/28/2008	9:35 AM	14 WNW	0.36	1.185
27	Atlas Road - A2 (2 1/2" RAP)	7/29/2008	3:50 PM	5 W	0.66	0.399
28	Atlas Road - A1 (1 1/2" RAP)	7/29/2008	4:00 PM	7 W	0.80	0.239
29	Atlas Road - A0 (100% Gravel)	7/29/2008	4:15 PM	6 W	0.74	0.732
30	Pry Road - P1 (1 1/2" RAP)	7/29/2008	4:25 PM	10 W	0.54	0.316
31	Pry Road - P0 (100% Gravel)	7/29/2008	4:35 PM	8 W	1.52	0.594
32	Atlas Road - A2 (2 1/2" RAP)	7/29/2008	4:55 PM	10 W	1.60	0.399
33	Atlas Road - A1 (1 1/2" RAP)	7/29/2008	4:50 PM	8 W	1.24	0.239
34	Atlas Road - A0 (100% Gravel)	7/29/2008	4:45 PM	12 W	2.50	0.732
35	Pry Road - P1 (1 1/2" RAP)	7/29/2008	4:40 PM	11 W	0.84	0.316
36	Pry Road - P0 (100% Gravel)	7/29/2008	4:30 PM	9 W	1.80	0.594
37	Atlas Road - A2 (2 1/2" RAP)	8/6/2008	8:00 AM	10 WNW	0.18	0.457
38	Atlas Road - A1 (1 1/2" RAP)	8/6/2008	8:10 AM	14 WNW	0.10	0.500
39	Atlas Road - A0 (100% Gravel)	8/6/2008	8:15 AM	15 NW	0.16	0.892
40	Pry Road - P1 (1 1/2" RAP)	8/6/2008	8:20 AM	16 NW	0.52	0.696
41	Pry Road - P0 (100% Gravel)	8/6/2008	8:30 AM	10 NW	1.98	0.845
42	Atlas Road - A2 (2 1/2" RAP)	8/6/2008	7:55 AM	12 NW	0.48	0.457
43	Atlas Road - A1 (1 1/2" RAP)	8/6/2008	7:45 AM	16 NW	0.70	0.500
44	Atlas Road - A0 (100% Gravel)	8/6/2008	7:35 AM	15 NW	0.56	0.892
45	Pry Road - P1 (1 1/2" RAP)	8/6/2008	8:45 AM	11 NW	0.30	0.696

Laramie County Dust, Moisture, and Wind Data						
#	**Test Section**	**Date of Sample**	**Time of Sample**	**Wind (mph)**	**1 mi. Dust Wt. (g)**	**Moisture Content (%)**
46	Pry Road - P0 (100% Gravel)	8/6/2008	8:40 AM	9 NW	1.26	0.845
47	Atlas Road - A2 (2 1/2" RAP)	8/7/2008	3:00 PM	11 S	0.40	0.425
48	Atlas Road - A1 (1 1/2" RAP)	8/7/2008	3:10 PM	10 S	0.44	0.377
49	Atlas Road - A0 (100% Gravel)	8/7/2008	3:25 PM	7 SE	0.70	0.722
50	Pry Road - P1 (1 1/2" RAP)	8/7/2008	3:30 PM	8 SE	0.36	0.291
51	Pry Road - P0 (100% Gravel)	8/7/2008	3:40 PM	10 S	0.62	0.599
52	Atlas Road - A2 (2 1/2" RAP)	8/7/2008	4:05 PM	8 S	0.34	0.425
53	Atlas Road - A1 (1 1/2" RAP)	8/7/2008	4:00 PM	9 S	0.10	0.377
54	Atlas Road - A0 (100% Gravel)	8/7/2008	3:55 PM	9 S	0.18	0.722
55	Pry Road - P1 (1 1/2" RAP)	8/7/2008	3:50 PM	12 S	0.40	0.291
56	Pry Road - P0 (100% Gravel)	8/7/2008	3:45 PM	15 S	0.44	0.599
57	Atlas Road - A2 (2 1/2" RAP)	8/13/2008	8:05 AM	15 NW	0.18	0.619
58	Atlas Road - A1 (1 1/2" RAP)	8/13/2008	8:15 AM	7 WNW	0.10	0.472
59	Atlas Road - A0 (100% Gravel)	8/13/2008	8:30 AM	12 NW	0.12	0.869
60	Pry Road - P1 (1 1/2" RAP)	8/13/2008	8:35 AM	11 NW	0.14	0.424
61	Pry Road - P0 (100% Gravel)	8/13/2008	8:45 AM	12 W	0.28	0.787
62	Atlas Road - A2 (2 1/2" RAP)	8/13/2008	9:15 AM	15 WNW	0.78	0.619
63	Atlas Road - A1 (1 1/2" RAP)	8/13/2008	9:10 AM	14 WNW	0.62	0.472
64	Atlas Road - A0 (100% Gravel)	8/13/2008	9:05 AM	16 WNW	0.94	0.869
65	Pry Road - P1 (1 1/2" RAP)	8/13/2008	9:00 AM	13 WNW	0.76	0.424
66	Pry Road - P0 (100% Gravel)	8/13/2008	8:55 AM	10 NW	0.80	0.787
67	Atlas Road - A2 (2 1/2" RAP)	8/21/2008	7:10 AM	3 NW	1.20	1.576
68	Atlas Road - A1 (1 1/2" RAP)	8/21/2008	7:20 AM	4 NW	0.82	1.275
69	Atlas Road - A0 (100% Gravel)	8/21/2008	7:30 AM	5 NW	2.70	2.061
70	Pry Road - P1 (1 1/2" RAP)	8/21/2008	7:35 AM	6NW	0.36	0.948
71	Pry Road - P0 (100% Gravel)	8/21/2008	7:45 AM	5 WNW	0.84	1.874
72	Atlas Road - A2 (2 1/2" RAP)	8/21/2008	8:15 AM	5 NW	0.32	1.576
73	Atlas Road - A1 (1 1/2" RAP)	8/21/2008	8:10 AM	3 NW	0.28	1.275
74	Atlas Road - A0 (100% Gravel)	8/21/2008	8:05 AM	4 WNW	0.68	2.061
75	Pry Road - P1 (1 1/2" RAP)	8/21/2008	8:00 AM	5 NW	1.20	0.948
76	Pry Road - P0 (100% Gravel)	8/21/2008	7:55 AM	4 NW	4.00	1.874
77	Atlas Road - A2 (2 1/2" RAP)	8/22/2008	12:25 PM	12 NE	0.22	0.550
78	Atlas Road - A1 (1 1/2" RAP)	8/22/2008	12:35 PM	10 NE	0.12	0.471
79	Atlas Road - A0 (100% Gravel)	8/22/2008	12:45 PM	11 NE	0.18	2.625
80	Pry Road - P1 (1 1/2" RAP)	8/22/2008	1:15 PM	14 NE	0.32	0.615
81	Pry Road - P0 (100% Gravel)	8/22/2008	1:10 PM	8 NE	1.52	0.704
82	Atlas Road - A2 (2 1/2" RAP)	8/22/2008	2:05 PM	8 NE	0.34	0.550
83	Atlas Road - A1 (1 1/2" RAP)	8/22/2008	1:40 PM	9 NE	0.48	0.471
84	Atlas Road - A0 (100% Gravel)	8/22/2008	1:30 PM	11 NE	0.80	2.625
85	Pry Road - P1 (1 1/2" RAP)	8/22/2008	12:50 PM	9 NE	1.16	0.615
86	Pry Road - P0 (100% Gravel)	8/22/2008	12:55 PM	13 NE	2.98	0.704
87	Atlas Road - A2 (2 1/2" RAP)	9/5/2008	3:40 PM	11 S	0.86	3.998
88	Atlas Road - A1 (1 1/2" RAP)	9/5/2008	3:50 PM	8 S	0.82	3.000
89	Atlas Road - A0 (100% Gravel)	9/5/2008	4:00 PM	10 S	0.52	2.891
90	Pry Road - P1 (1 1/2" RAP)	9/5/2008	4:05 PM	13 S	0.94	1.935

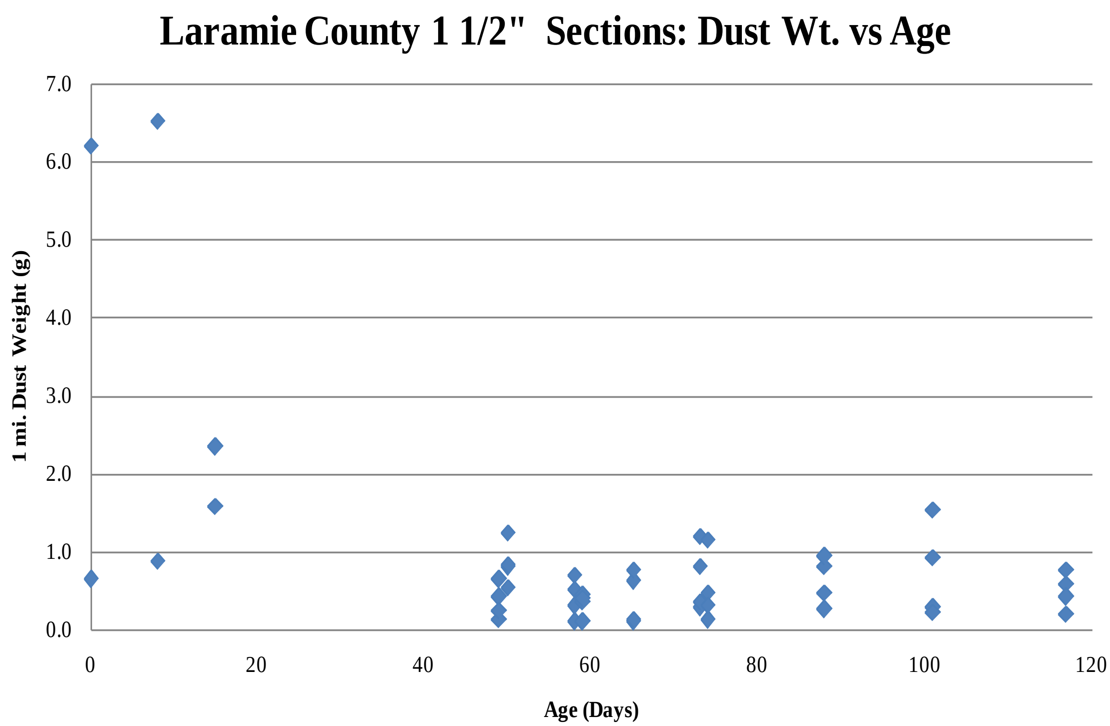
Laramie County Dust, Moisture, and Wind Data						
#	Test Section	Date of Sample	Time of Sample	Wind (mph)	1 mi. Dust Wt. (g)	Moisture Content (%)
91	Pry Road - P0 (100% Gravel)	9/5/2008	4:15 PM	12 S	0.94	2.675
92	Atlas Road - A2 (2 1/2" RAP)	9/5/2008	5:30 PM	12 S	0.22	3.998
93	Atlas Road - A1 (1 1/2" RAP)	9/5/2008	5:05 PM	7 S	0.26	3.000
94	Atlas Road - A0 (100% Gravel)	9/5/2008	4:55 PM	8 S	0.30	2.891
95	Pry Road - P1 (1 1/2" RAP)	9/5/2008	4:40 PM	9 S	0.48	1.935
96	Pry Road - P0 (100% Gravel)	9/5/2008	4:30 PM	15 S	0.86	2.675
97	Atlas Road - A2 (2 1/2" RAP)	9/18/2008	3:15 PM	12 SSW	1.40	0.305
98	Atlas Road - A1 (1 1/2" RAP)	9/18/2008	3:20 PM	11 SSW	0.92	0.504
99	Atlas Road - A0 (100% Gravel)	9/18/2008	3:25 PM	13 SSW	1.60	1.229
100	Pry Road - P1 (1 1/2" RAP)	9/18/2008	3:30 PM	12 SSW	0.22	0.715
101	Pry Road - P0 (100% Gravel)	9/18/2008	3:35 PM	10 SSW	0.52	1.312
102	Atlas Road - A2 (2 1/2" RAP)	9/18/2008	3:10 PM	10 SSW	0.54	0.305
103	Atlas Road - A1 (1 1/2" RAP)	9/18/2008	3:00 PM	9 S	0.28	0.504
104	Atlas Road - A0 (100% Gravel)	9/18/2008	2:55 PM	9 S	0.80	1.229
105	Pry Road - P1 (1 1/2" RAP)	9/18/2008	2:45 PM	8 S	1.54	0.715
106	Pry Road - P0 (100% Gravel)	9/18/2008	2:40 PM	7 S	2.18	1.312
107	Atlas Road - A2 (2 1/2" RAP)	10/4/2008	2:55 PM	10 S	0.18	0.985
108	Atlas Road - A1 (1 1/2" RAP)	10/4/2008	2:50 PM	8 S	0.20	0.505
109	Atlas Road - A0 (100% Gravel)	10/4/2008	2:45 PM	9 S	0.16	1.404
110	Pry Road - P1 (1 1/2" RAP)	10/4/2008	2:15 PM	13 S	0.76	0.480
111	Pry Road - P0 (100% Gravel)	10/4/2008	2:20 PM	11 S	1.54	0.757
112	Atlas Road - A2 (2 1/2" RAP)	10/4/2008	1:50 PM	11 S	0.56	0.985
113	Atlas Road - A1 (1 1/2" RAP)	10/4/2008	2:00 PM	10 S	0.58	0.505
114	Atlas Road - A0 (100% Gravel)	10/4/2008	2:10 PM	10 S	0.76	1.404
115	Pry Road - P1 (1 1/2" RAP)	10/4/2008	2:35 PM	13 S	0.42	0.480
116	Pry Road - P0 (100% Gravel)	10/4/2008	2:30 PM	12 S	0.94	0.757
117	Atlas Road - A2 (2 1/2" RAP)	2/17/2009	12:25 PM	8 NW	0.60	0.722
118	Atlas Road - A1 (1 1/2" RAP)	2/17/2009	12:20 PM	9 NW	0.50	2.147
119	Atlas Road - A0 (100% Gravel)	2/17/2009	12:15 PM	11 NW	0.98	2.305
120	Pry Road - P1 (1 1/2" RAP)	2/17/2009	12:05 PM	10 NW	0.54	2.098
121	Pry Road - P0 (100% Gravel)	2/17/2009	12:00 PM	11 NW	0.36	2.067
122	Atlas Road - A2 (2 1/2" RAP)	6/25/2009	9:00 AM	10 S	2.10	0.739
123	Atlas Road - A1 (1 1/2" RAP)	6/25/2009	9:10 AM	5 S	1.54	0.918
124	Atlas Road - A0 (100% Gravel)	6/25/2009	9:18 AM	7 S	1.04	0.615
125	Pry Road - P1 (1 1/2" RAP)	6/25/2009	9:23 AM	6 S	2.06	0.209
126	Pry Road - P0 (100% Gravel)	6/25/2009	9:30 AM	9 S	1.44	0.508
127	Atlas Road - A2 (2 1/2" RAP)	6/25/2009	9:52 AM	8 S	0.62	0.739
128	Atlas Road - A1 (1 1/2" RAP)	6/25/2009	9:48 AM	8 S	0.48	0.918
129	Atlas Road - A0 (100% Gravel)	6/25/2009	9:43 AM	6 S	0.52	0.615
130	Pry Road - P1 (1 1/2" RAP)	6/25/2009	9:38 AM	8 S	1.98	0.209
131	Pry Road - P0 (100% Gravel)	6/25/2009	9:35 AM	9 S	1.38	0.508

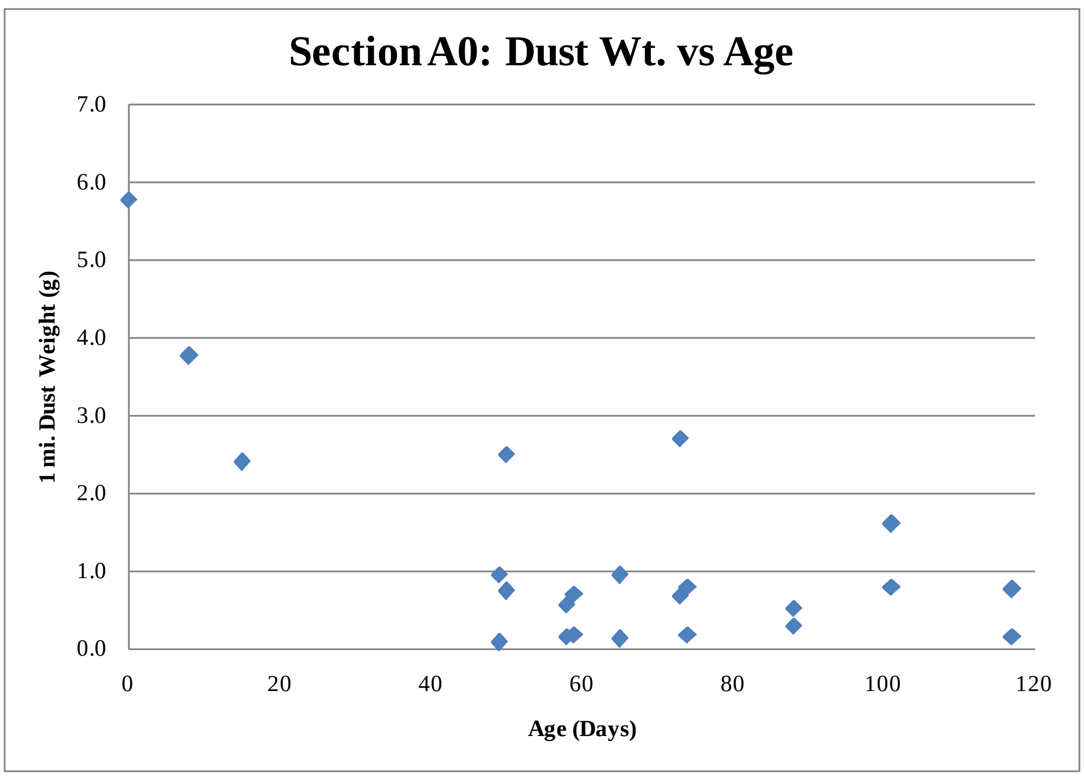


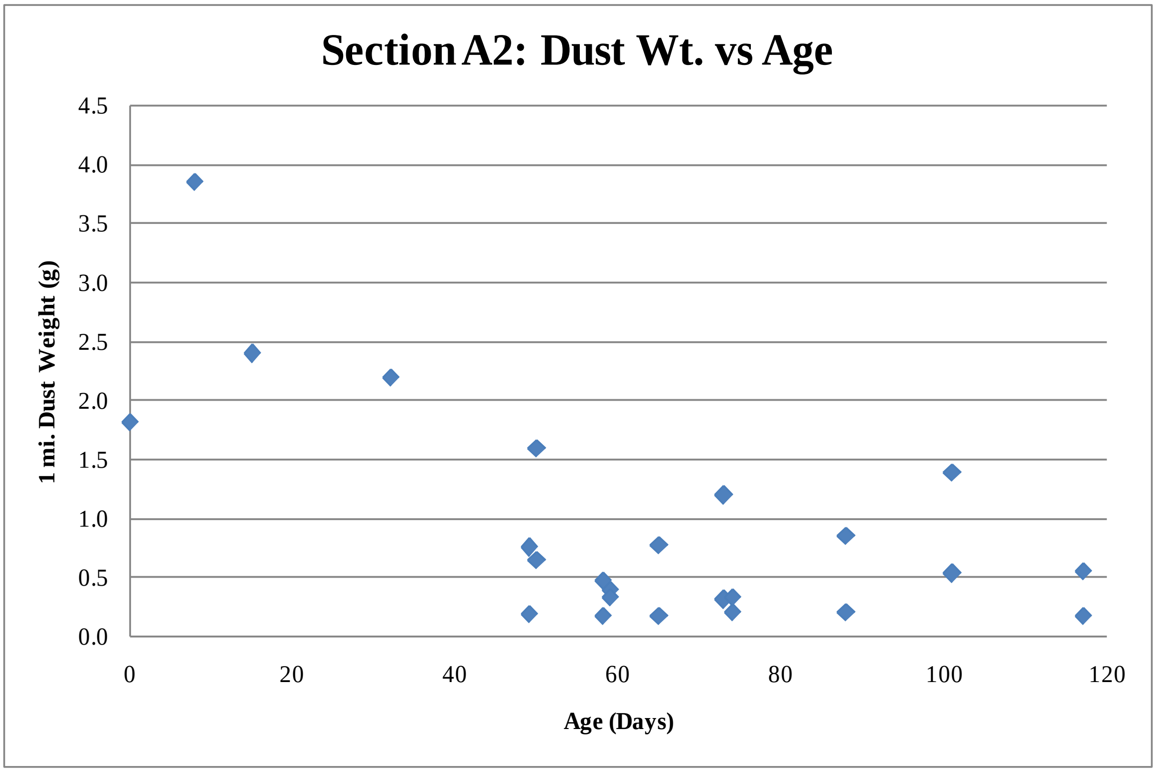
Laramie County Dust Wt. vs Age
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
1 mi. Dust Weight (g)
0
20
40
60
80
100
120
Age (Days)



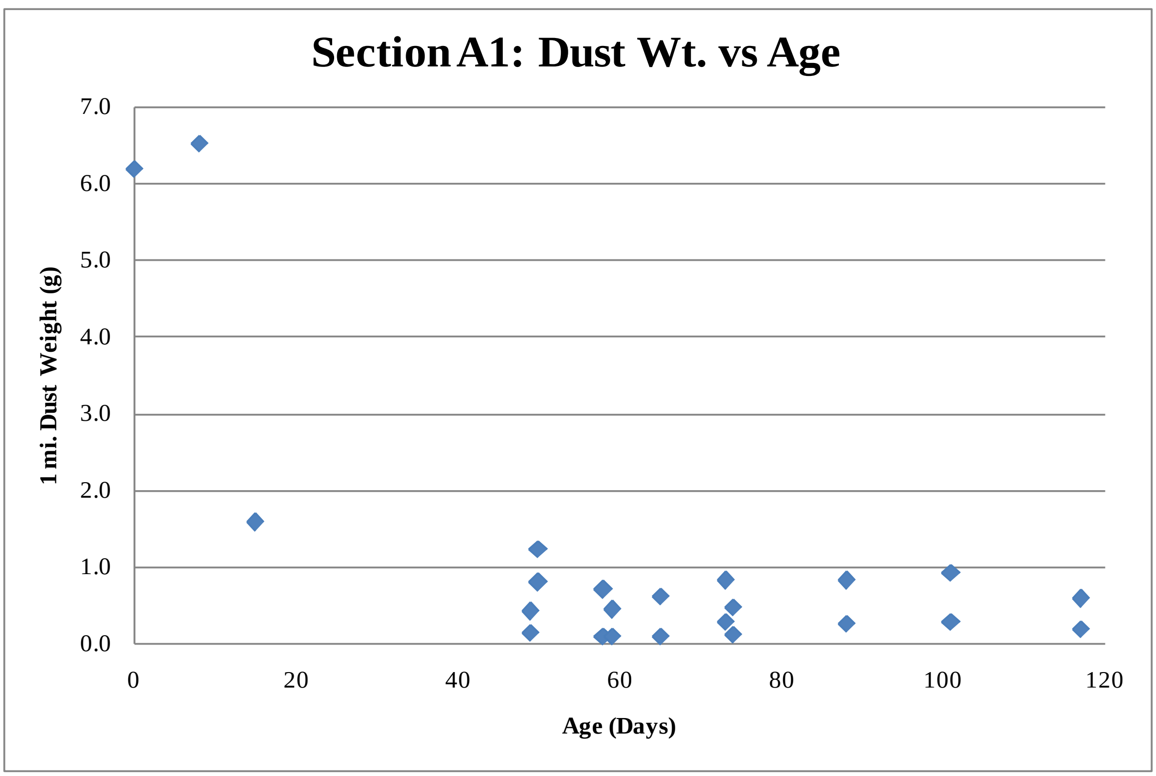
Laramie County Control Sections: Dust Wt. vs Age
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
1 mi. Dust Weight (g)
0
20
40
60
80
100
120
Age (Days)


Laramie County 1 1/2" Sections: Dust Wt. vs Age
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
0
20
40
60
80
100
120
1 mi. Dust Weight (g)
Age (Days)

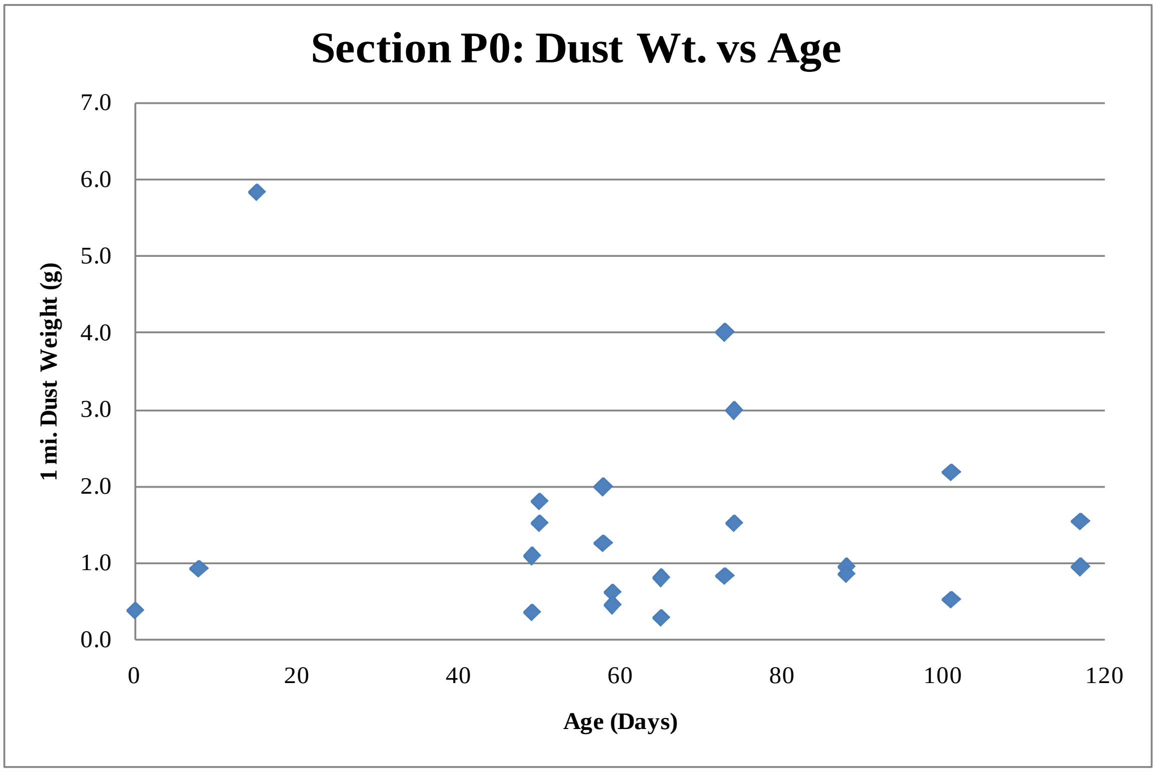

Section A0: Dust Wt. vs Age
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
0
20
40
60
80
100
120
1 mi. Dust Weight (g)
Age (Days)

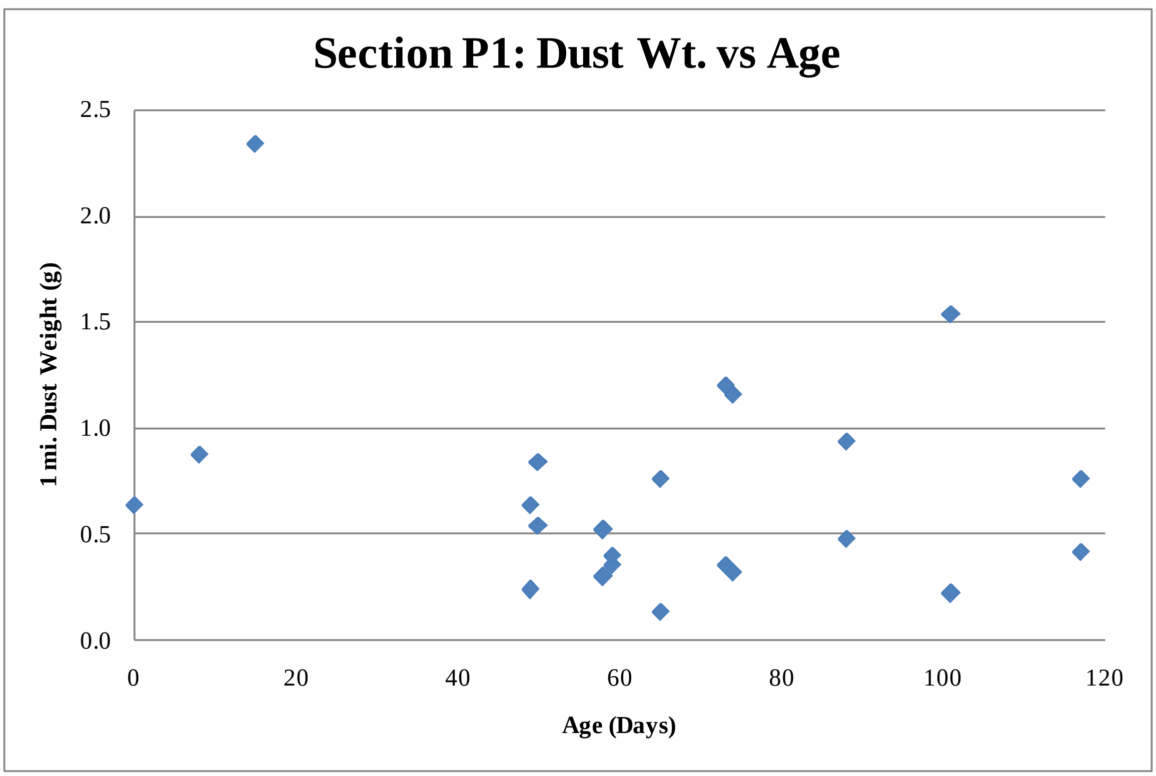


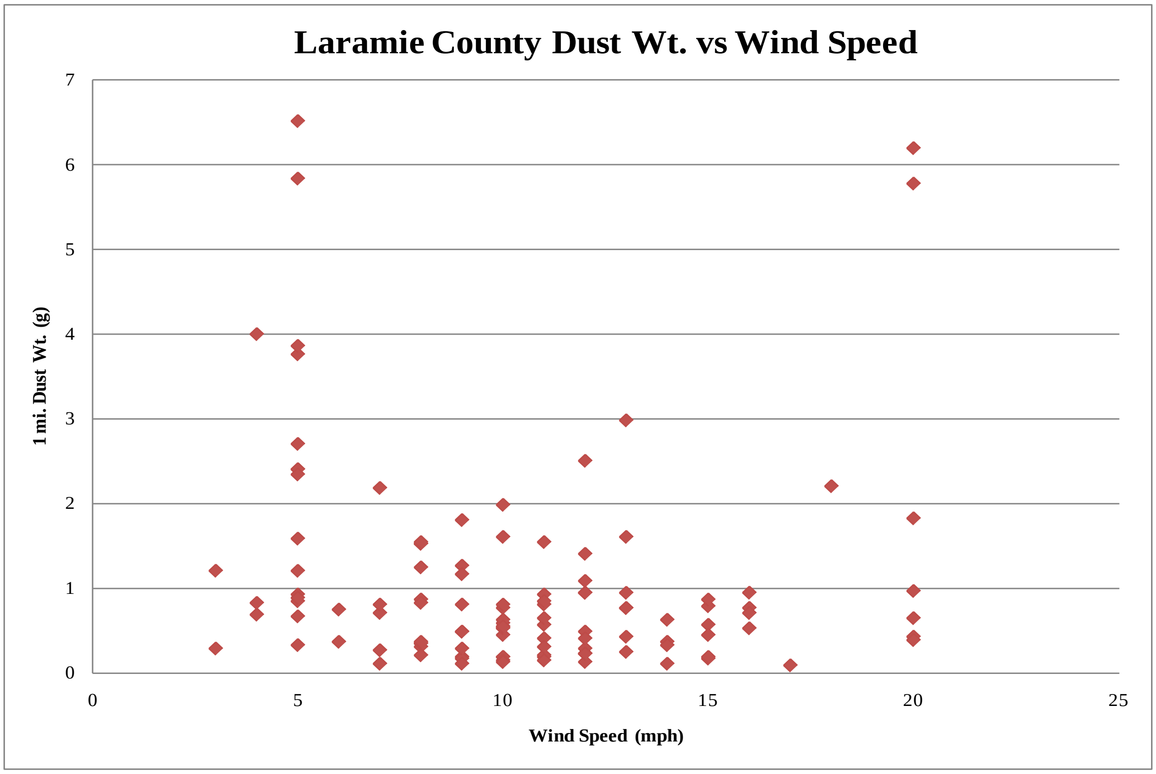
Section A2: Dust Wt. vs Age
1 mi. Dust Weight (g)
4.5
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0.0
0
20
40
60
80
100
120
Age (Days)

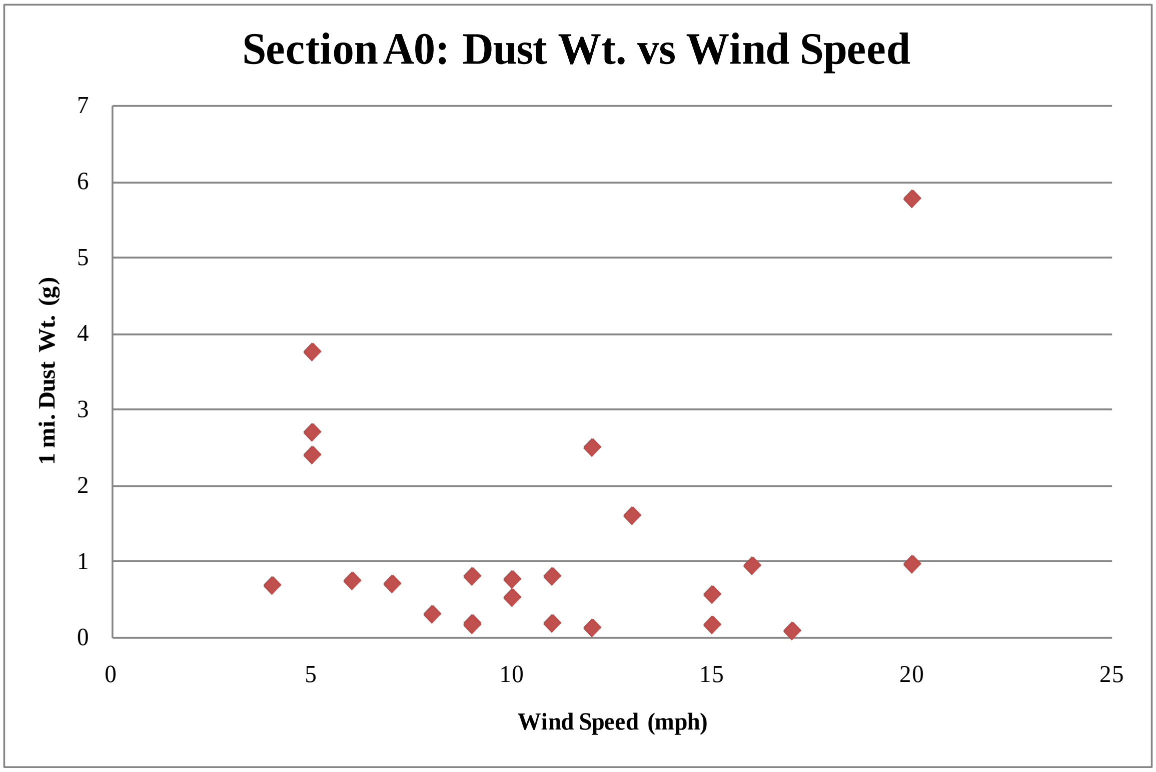


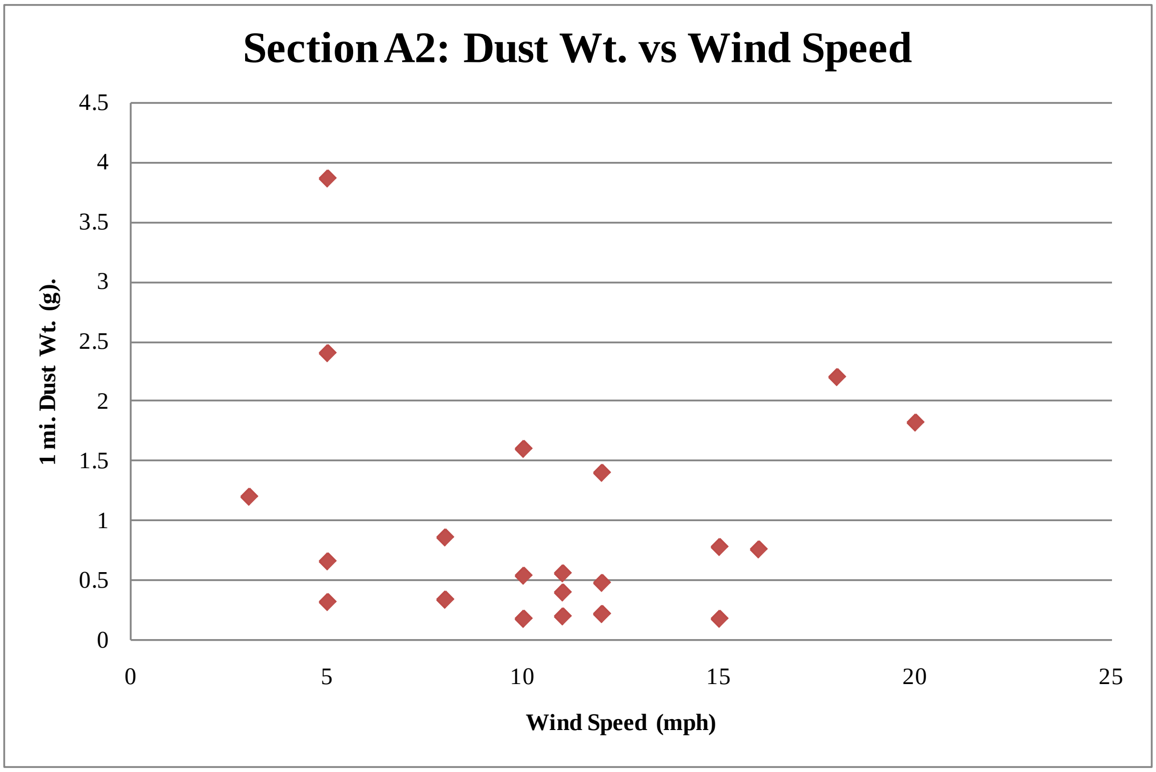
Section A1: Dust Wt. vs Age
1 mi. Dust Weight (g)
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
0
20
40
60
80
100
120
Age (Days)

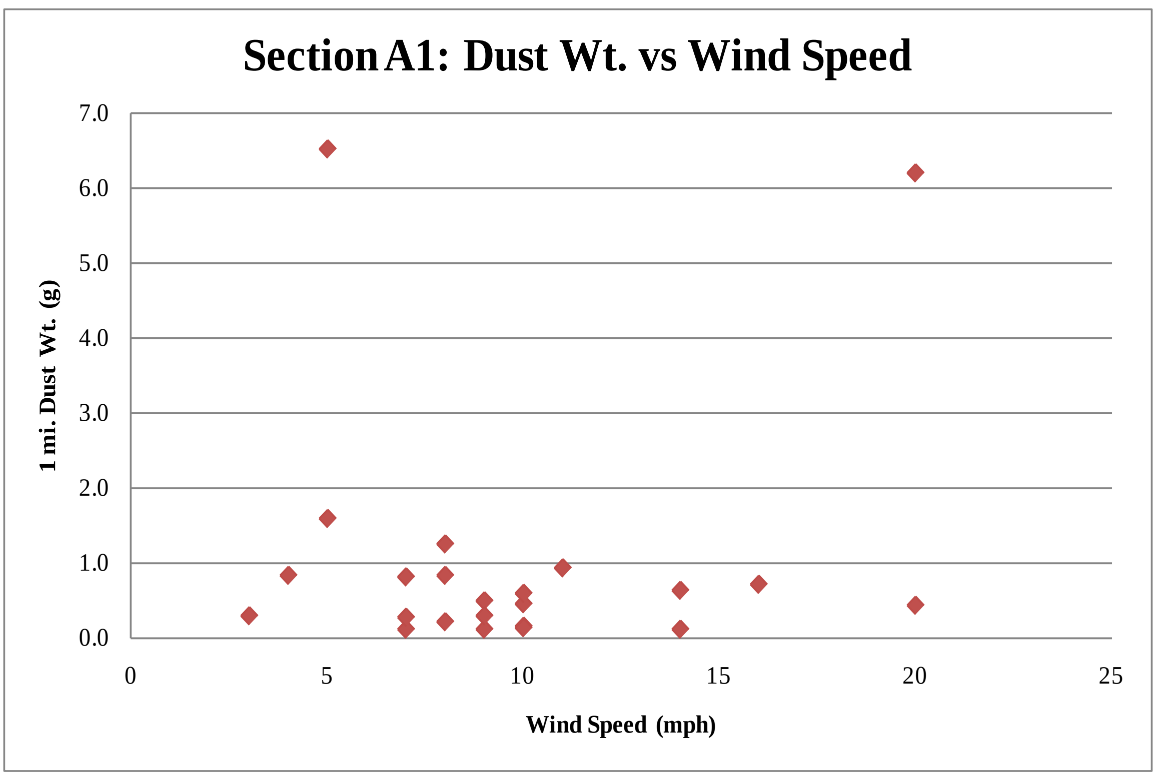

Section P0: Dust Wt. vs Age
1 mi. Dust Weight (g)
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
0
20
40
60
80
100
120
Age (Days)

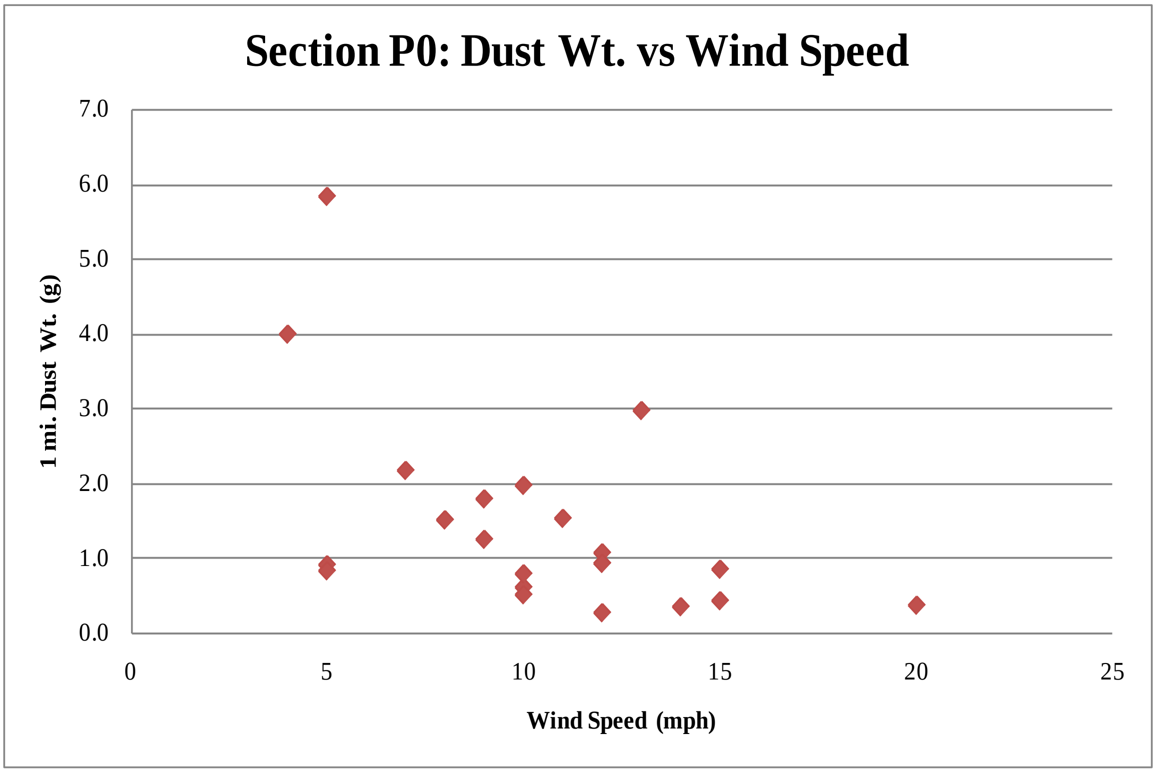

Section P1: Dust Wt. vs Age
1 mi. Dust Weight (g)
2.5
2.0
1.5
1.0
0.5
0.0
0
20
40
60
80
100
120
Age (Days)

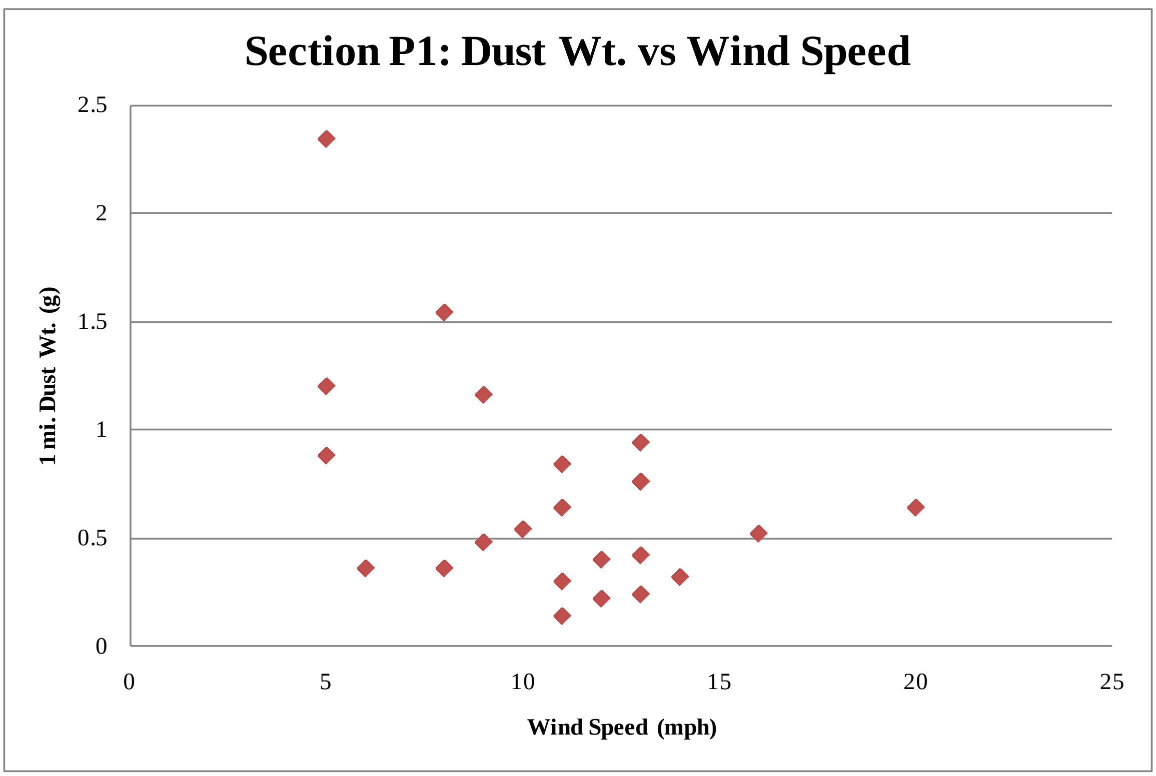

Laramie County Dust Wt. vs Wind Speed
1 mi. Dust Wt. (g)
0
1
2
3
4
5
6
7
0
5
10
15
20
25
Wind Speed (mph)


Section A0: Dust Wt. vs Wind Speed
1 mi. Dust Wt. (g)
0
1
2
3
4
5
6
7
0
5
10
15
20
25
Wind Speed (mph)

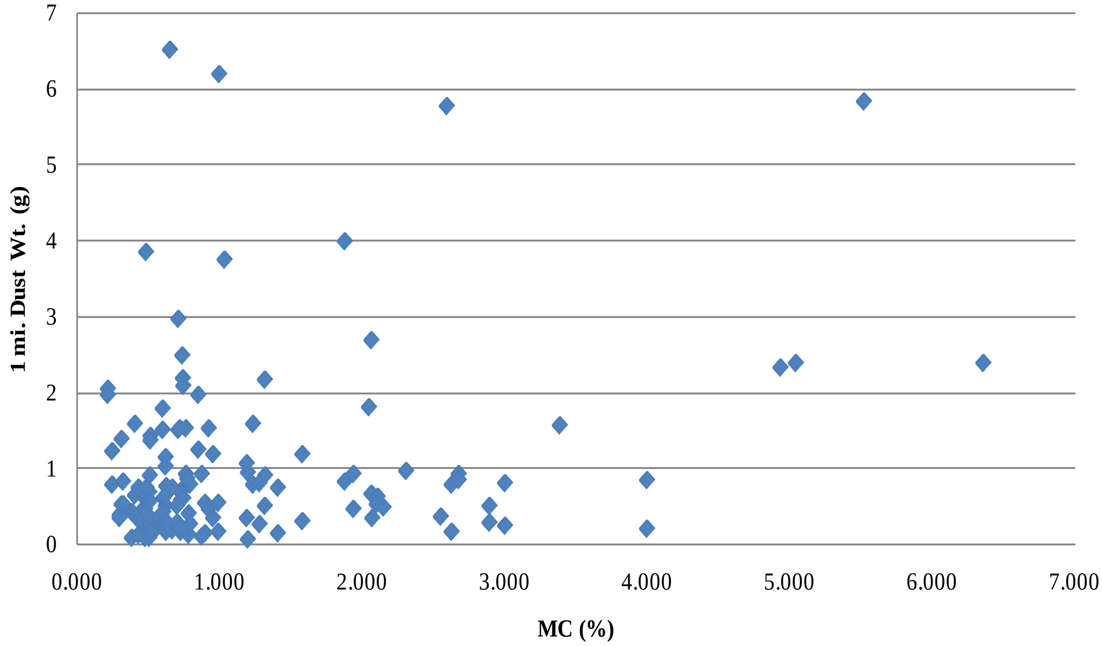

Section A2: Dust Wt. vs Wind Speed
1 mi. Dust Wt. (g).
4.5
4
3.5
3
2.5
2
1.5
1
0.5
0
0
5
10
15
20
25
Wind Speed (mph)


Section A1: Dust Wt. vs Wind Speed
1 mi. Dust Wt. (g)
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
0
5
10
15
20
25
Wind Speed (mph)

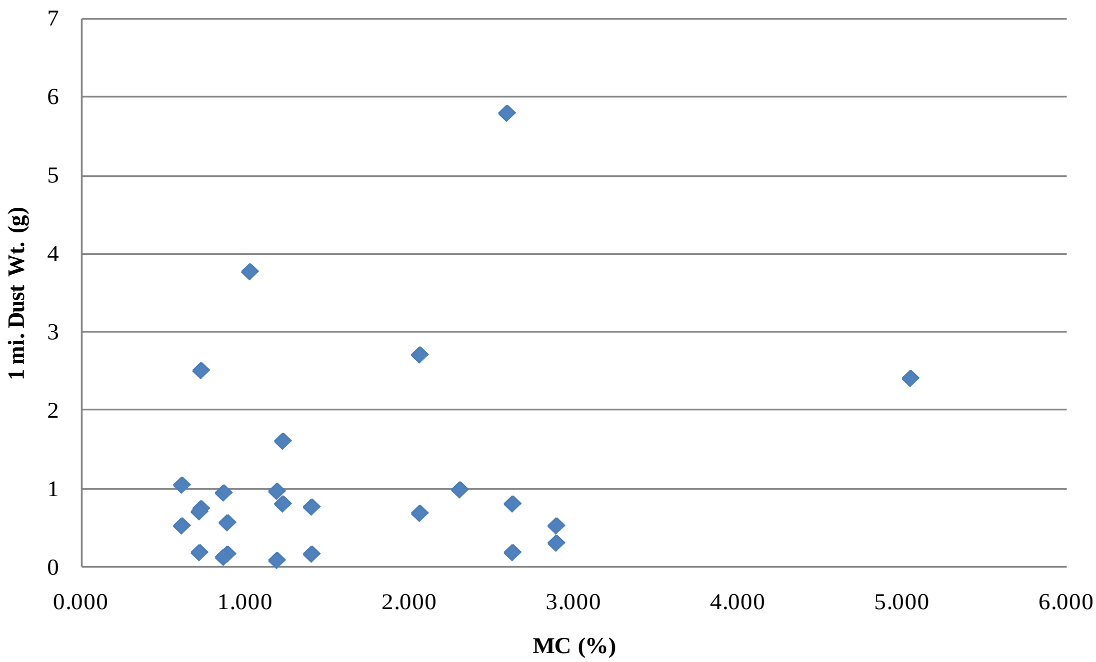

Section P0: Dust Wt. vs Wind Speed
1 mi. Dust Wt. (g)
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0.0
0
5
10
15
20
25
Wind Speed (mph)

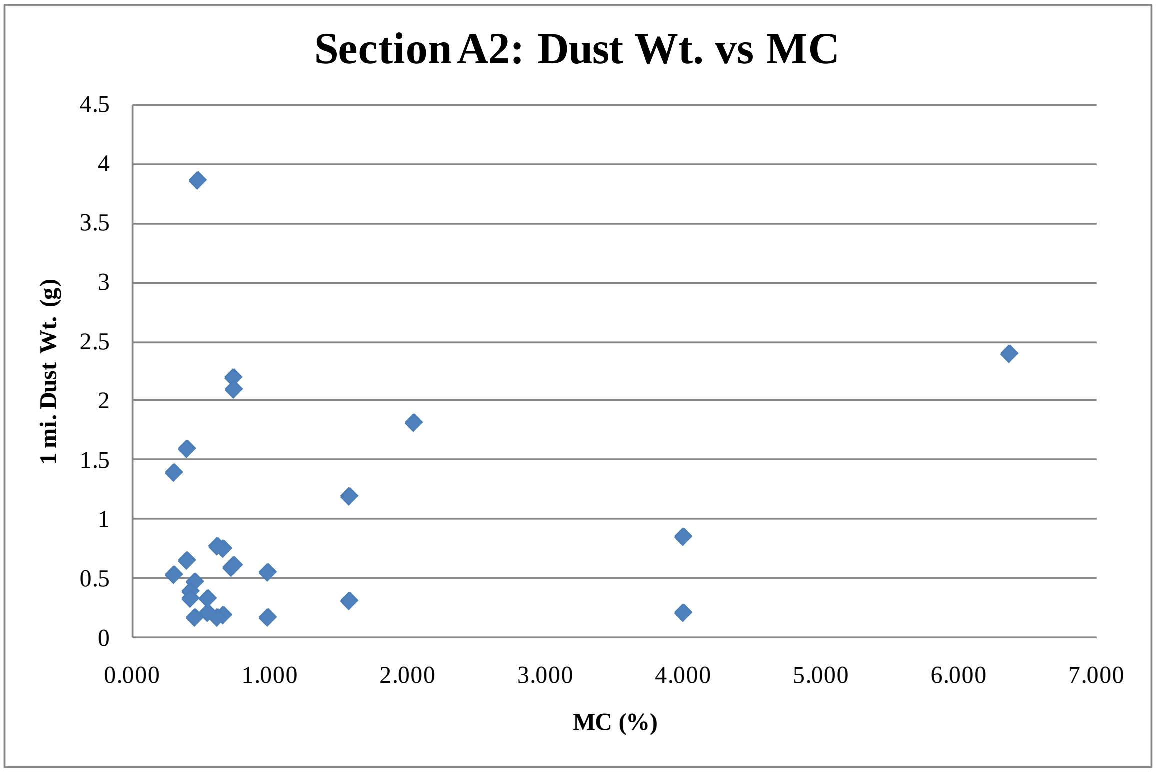

Section P1: Dust Wt. vs Wind Speed
1 mi. Dust Wt. (g)
2.5
2
1.5
1
0.5
0
0
5
10
15
20
25
Wind Speed (mph)

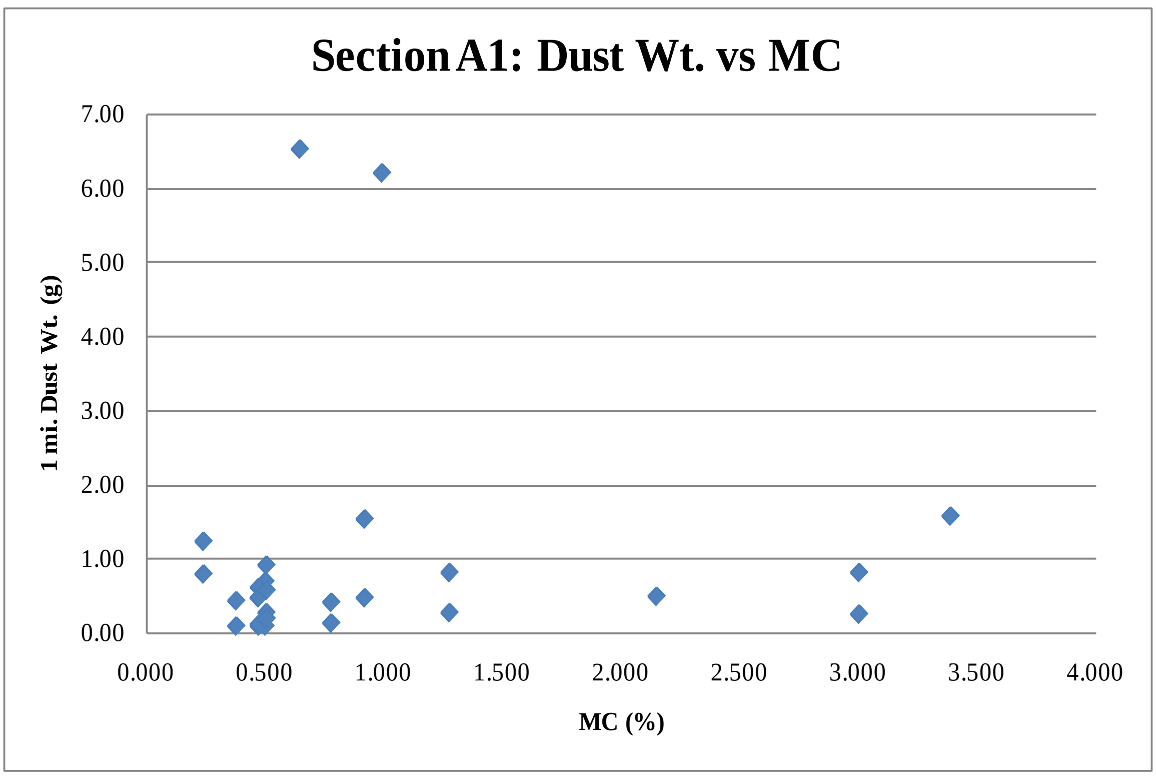
Laramie County Dust Wt. vs Moisture Content

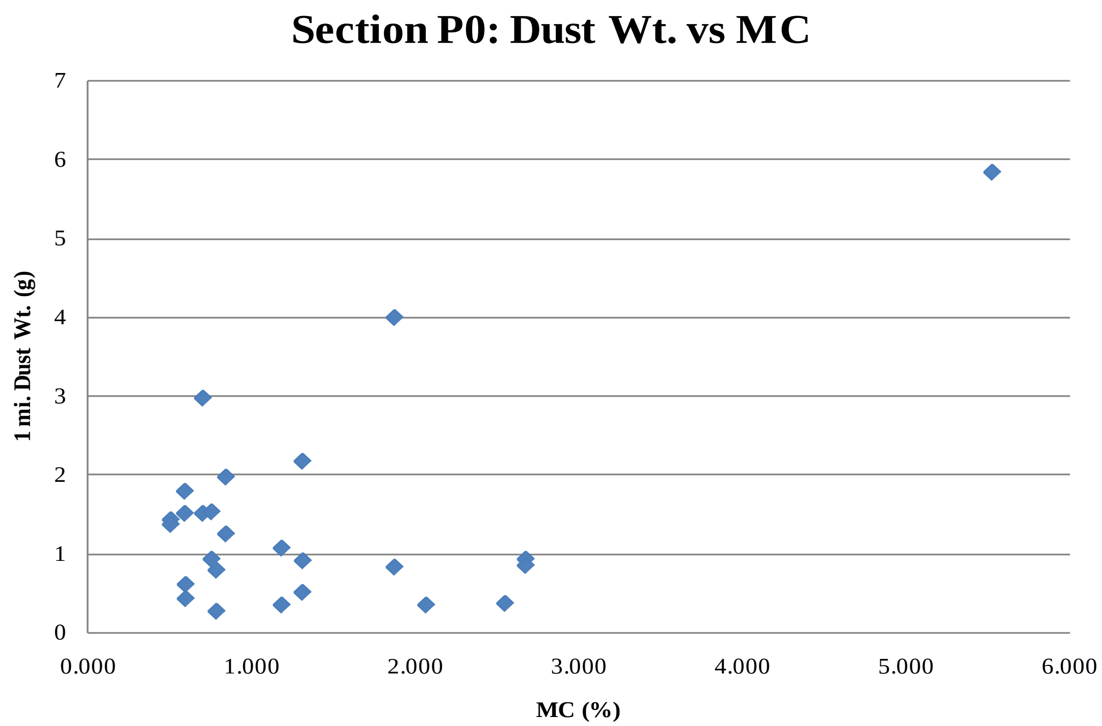


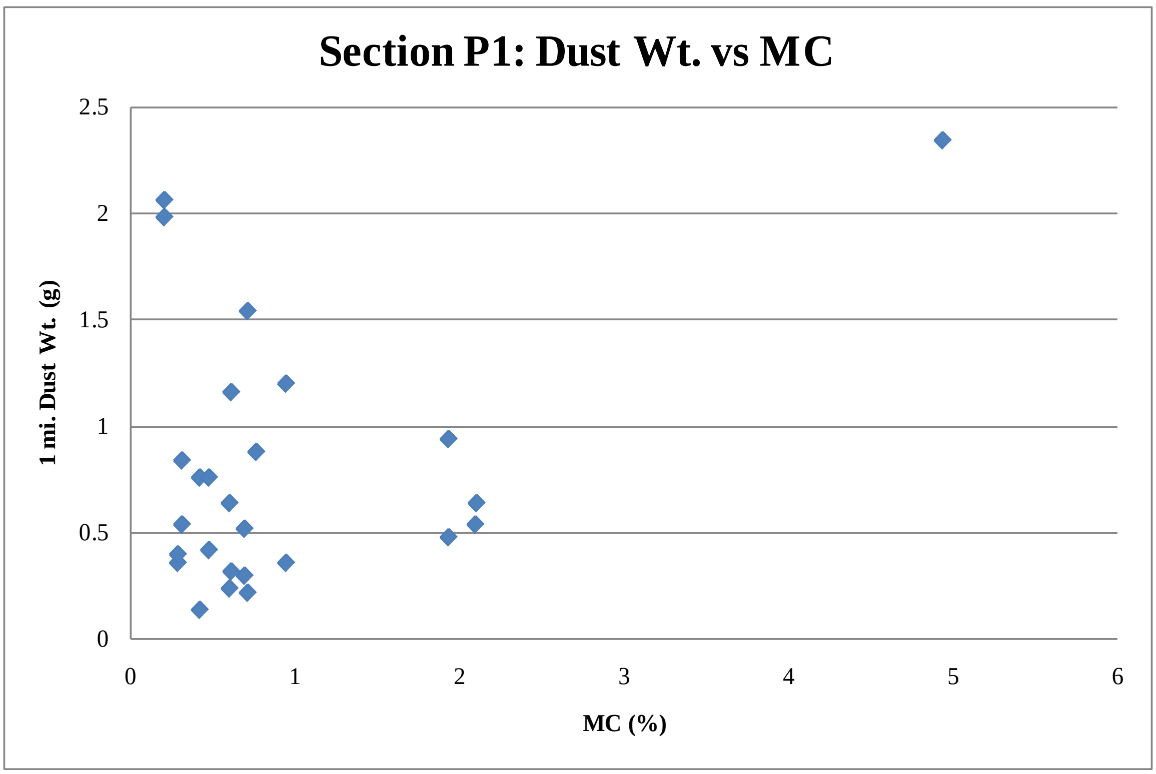
Section A0: Dust Wt. vs MC




Section A2: Dust Wt. vs MC
4.5
4
3.5
3
2.5
2
1.5
1
0.5
0
1 mi. Dust Wt. (g)
0.000
1.000
2.000
3.000
4.000
5.000
6.000
7.000
MC (%)

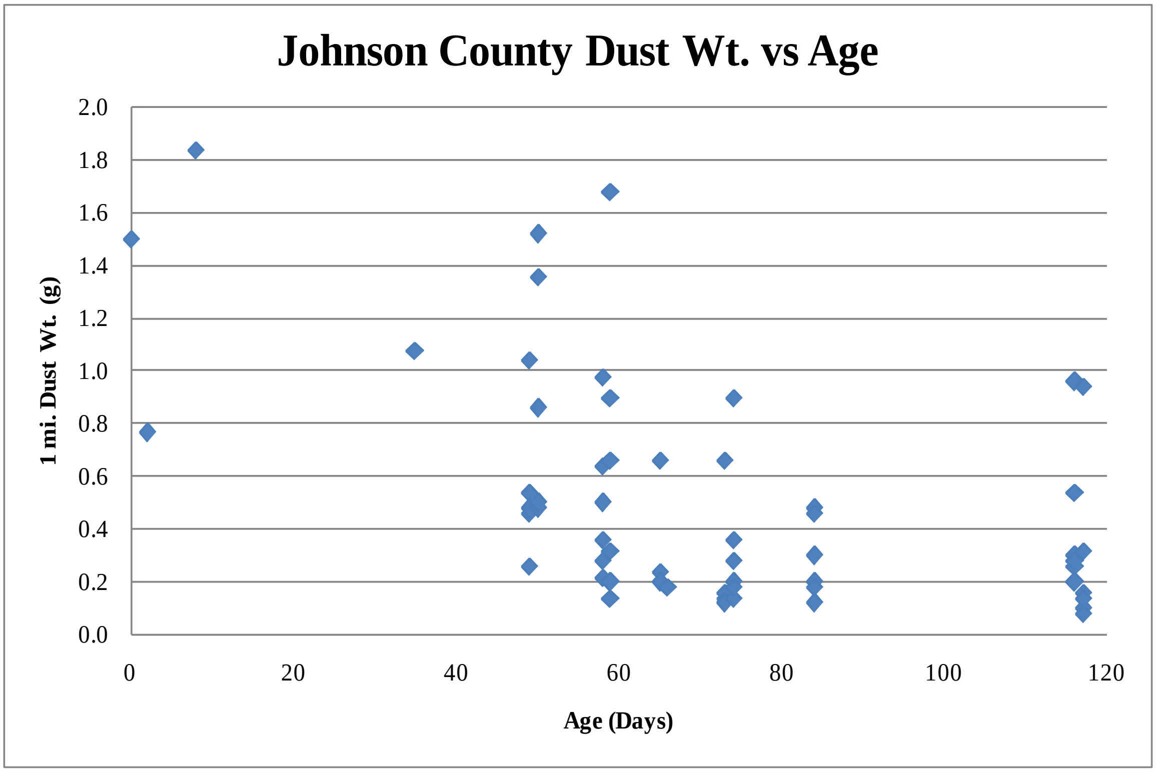

Section A1: Dust Wt. vs MC
7.00
6.00
5.00
4.00
3.00
2.00
1.00
0.00
1 mi. Dust Wt. (g)
0.000
0.500
1.000
1.500
2.000
2.500
3.000
3.500
4.000
MC (%)

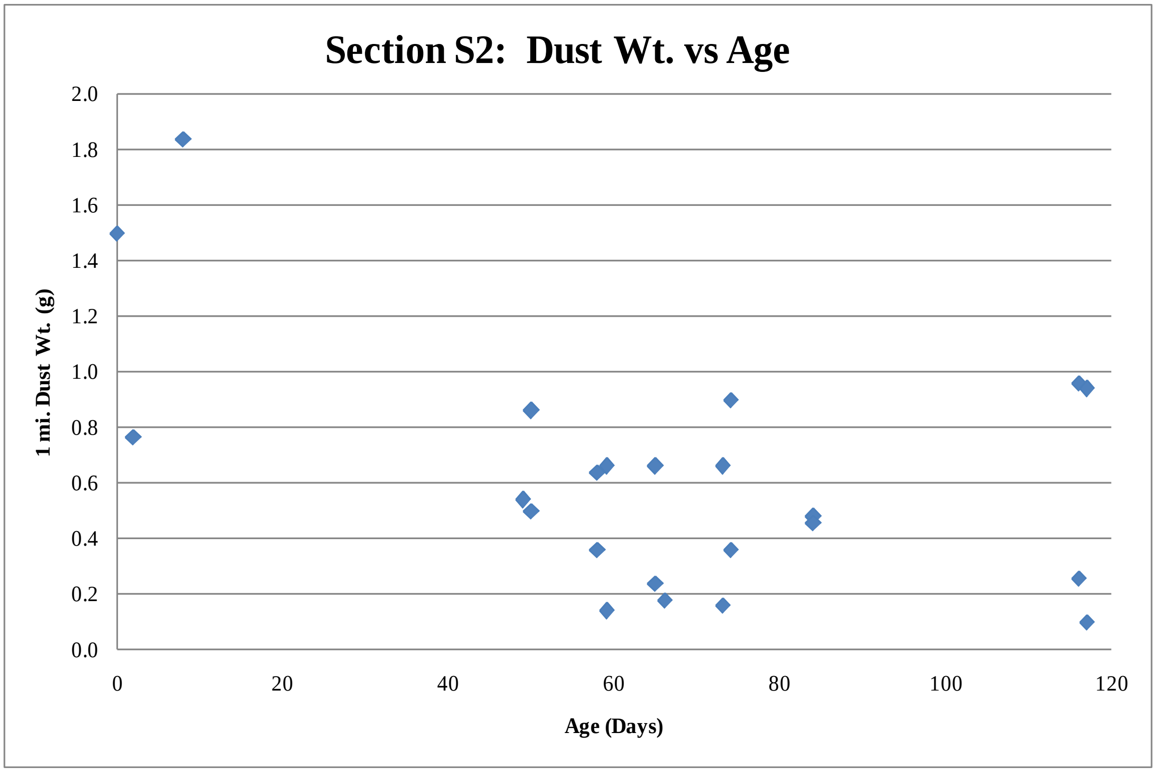

Section P0: Dust Wt. vs MC
7
6
5
4
3
2
1
0
0.000
1.000
2.000
3.000
4.000
5.000
6.000
MC (%)
1 mi. Dust Wt. (g)

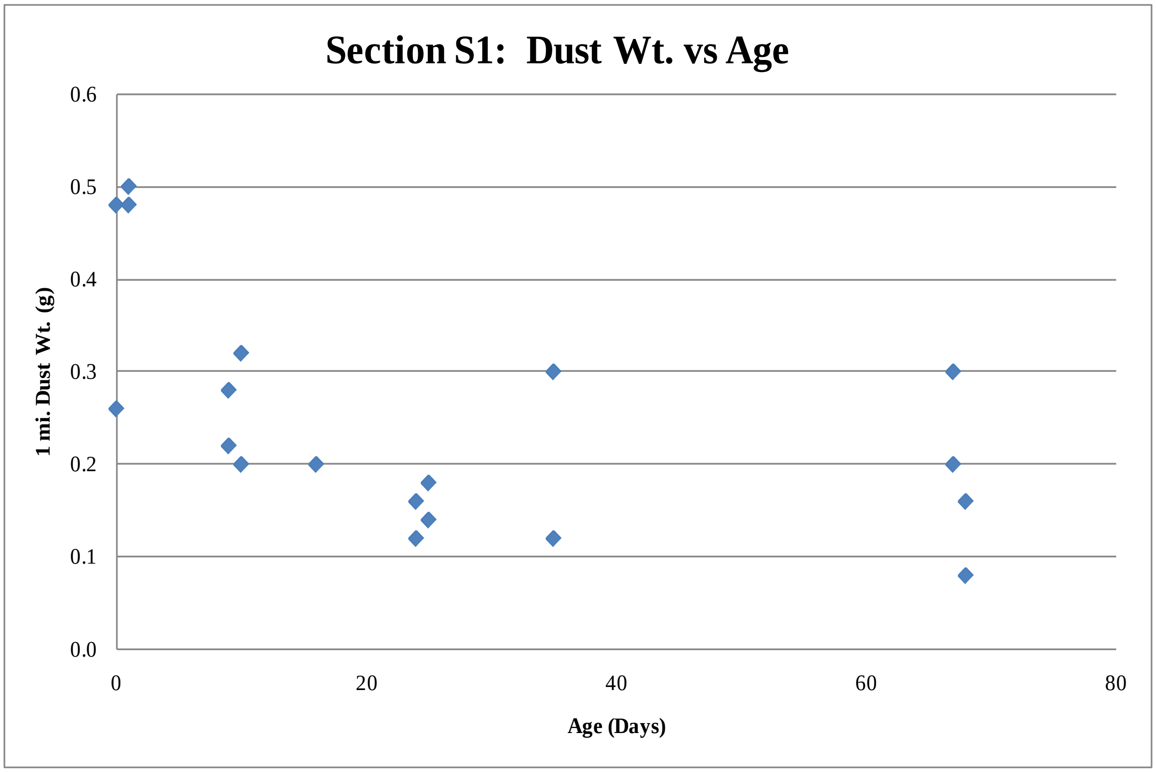

Section P1: Dust Wt. vs MC
2.5
2
1.5
1
0.5
0
0
1
2
3
4
5
6
MC (%)
1 mi. Dust Wt. (g)

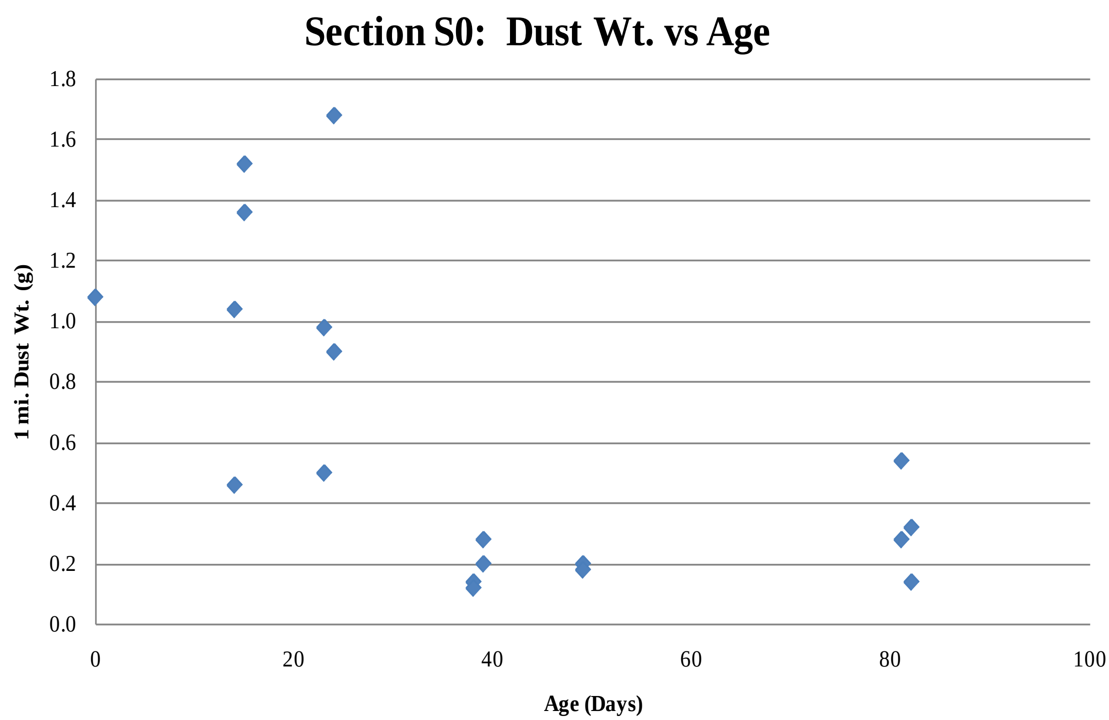
Johnson County Dust, Moisture Content, and Wind Data						
#	Test Section	Date of Sample	Time of Sample	Wind (mph)	1 mi. Dust Wt. (g)	Moisture Content (%)
1	Section 1 & 2 of RAP (no dust abatement)	6/9/2008	2:15 PM	10 NNW	1.50	2.117
2	Section 1 & 2 of RAP (no dust abatement)	6/11/2008	9:05 AM	10 NNW	0.77	1.904
3	Section 1 & 2 of RAP (no dust abatement)	6/17/2008	12:45 PM	10 NNW	1.84	0.316
4	Schoonover Road - S0 (100% Gravel w/ CaCl)	7/14/2008	12:45 PM	15 NNW	1.08	1.657
5	Schoonover Road - S2 (RAP Blend)	7/28/2008	4:00 PM	5 N	0.54	0.348
6	Schoonover Road - S1 (RAP Blend w/ CaCl)	7/28/2008	4:10 PM	5 N	0.26	1.692
7	Schoonover Road - S0 (100% Gravel w/ CaCl)	7/28/2008	4:20 PM	5 N	0.46	1.282
8	Schoonover Road - S2 (RAP Blend)	7/28/2008	4:35 PM	5 N	0.54	0.348
9	Schoonover Road - S1 (RAP Blend w/ CaCl)	7/28/2008	4:30 PM	5 N	0.48	1.692
10	Schoonover Road - S0 (100% Gravel w/ CaCl)	7/28/2008	4:25 PM	5 N	1.04	1.282
11	Schoonover Road - S2 (RAP Blend)	7/29/2008	9:45 AM	0	0.86	0.504
12	Schoonover Road - S1 (RAP Blend w/ CaCl)	7/29/2008	9:50 AM	0	0.48	1.569
13	Schoonover Road - S0 (100% Gravel w/ CaCl)	7/29/2008	9:55 AM	0	1.52	1.741
14	Schoonover Road - S2 (RAP Blend)	7/29/2008	9:40 AM	0	0.50	0.504
15	Schoonover Road - S1 (RAP Blend w/ CaCl)	7/29/2008	9:30 AM	0	0.50	1.569
16	Schoonover Road - S0 (100% Gravel w/ CaCl)	7/29/2008	9:20 AM	0	1.36	1.741
17	Schoonover Road - S2 (RAP Blend)	8/6/2008	3:20 PM	3 N	0.64	0.331
18	Schoonover Road - S1 (RAP Blend w/ CaCl)	8/6/2008	3:15 PM	4 NE	0.28	1.297
19	Schoonover Road - S0 (100% Gravel w/ CaCl)	8/6/2008	3:10 PM	3 NE	0.98	0.698
20	Schoonover Road - S2 (RAP Blend)	8/6/2008	2:40 PM	6 NE	0.36	0.331
21	Schoonover Road - S1 (RAP Blend w/ CaCl)	8/6/2008	2:55 PM	2 N	0.22	1.297
22	Schoonover Road - S0 (100% Gravel w/ CaCl)	8/6/2008	3:05 PM	0	0.50	0.698
23	Schoonover Road - S2 (RAP Blend)	8/7/2008	10:35 AM	14 SSE	0.66	0.509
24	Schoonover Road - S1 (RAP Blend w/ CaCl)	8/7/2008	9:55 AM	15 SSE	0.32	1.118
25	Schoonover Road - S0 (100% Gravel w/ CaCl)	8/7/2008	10:10 AM	12 SSE	1.68	1.523
26	Schoonover Road - S2 (RAP Blend)	8/7/2008	10:30 AM	16 SSE	0.14	0.509
27	Schoonover Road - S1 (RAP Blend w/ CaCl)	8/7/2008	10:25 AM	18 SSE	0.20	1.118
28	Schoonover Road - S0 (100% Gravel w/ CaCl)	8/7/2008	10:20 AM	17 SSE	0.90	1.523
29	Schoonover Road - S2 (RAP Blend)	8/13/2008	3:35 PM	7 ESE	0.24	0.251
30	Schoonover Road - S2 (RAP Blend)	8/13/2008	3:30 PM	3 ESE	0.66	0.251
31	Schoonover Road - S1 (RAP Blend w/ CaCl)	8/13/2008	3:15 PM	5 SE	0.20	0.743
32	Schoonover Road - S2 (RAP Blend)	8/14/2008	10:10 AM	10 WNW	0.18	0.270
33	Schoonover Road - S2 (RAP Blend)	8/21/2008	12:30 PM	12 S	0.66	0.291
34	Schoonover Road - S1 (RAP Blend w/ CaCl)	8/21/2008	12:45 PM	18 S	0.16	1.280
35	Schoonover Road - S0 (100% Gravel w/ CaCl)	8/21/2008	12:55 PM	10 S	0.14	1.301
36	Schoonover Road - S2 (RAP Blend)	8/21/2008	1:10 PM	15 S	0.16	0.291
37	Schoonover Road - S1 (RAP Blend w/ CaCl)	8/21/2008	1:05 PM	13 S	0.12	1.280
38	Schoonover Road - S0 (100% Gravel w/ CaCl)	8/21/2008	1:00 PM	11 S	0.12	1.301
39	Schoonover Road - S2 (RAP Blend)	8/22/2008	7:45 AM	8 NNW	0.36	0.422
40	Schoonover Road - S1 (RAP Blend w/ CaCl)	8/22/2008	8:00 AM	6 NW	0.14	1.311
41	Schoonover Road - S0 (100% Gravel w/ CaCl)	8/22/2008	8:05 AM	9 WNW	0.20	1.789
42	Schoonover Road - S2 (RAP Blend)	8/22/2008	8:20 AM	9 NW	0.90	0.422
43	Schoonover Road - S1 (RAP Blend w/ CaCl)	8/22/2008	8:15 AM	7 NW	0.18	1.311
44	Schoonover Road - S0 (100% Gravel w/ CaCl)	8/22/2008	8:10 AM	10 NNW	0.28	1.789
45	Schoonover Road - S2 (RAP Blend)	9/1/2008	10:25 AM	5 NW	0.48	0.429
46	Schoonover Road - S1 (RAP Blend w/ CaCl)	9/1/2008	10:20 AM	2 NW	0.30	2.102
47	Schoonover Road - S0 (100% Gravel w/ CaCl)	9/1/2008	10:10 AM	3 NW	0.20	2.584
48	Schoonover Road - S2 (RAP Blend)	9/1/2008	10:30 AM	5 NW	0.46	0.429
49	Schoonover Road - S1 (RAP Blend w/ CaCl)	9/1/2008	10:35 AM	5 NW	0.12	2.102
50	Schoonover Road - S0 (100% Gravel w/ CaCl)	9/1/2008	10:40 AM	4 NW	0.18	2.584

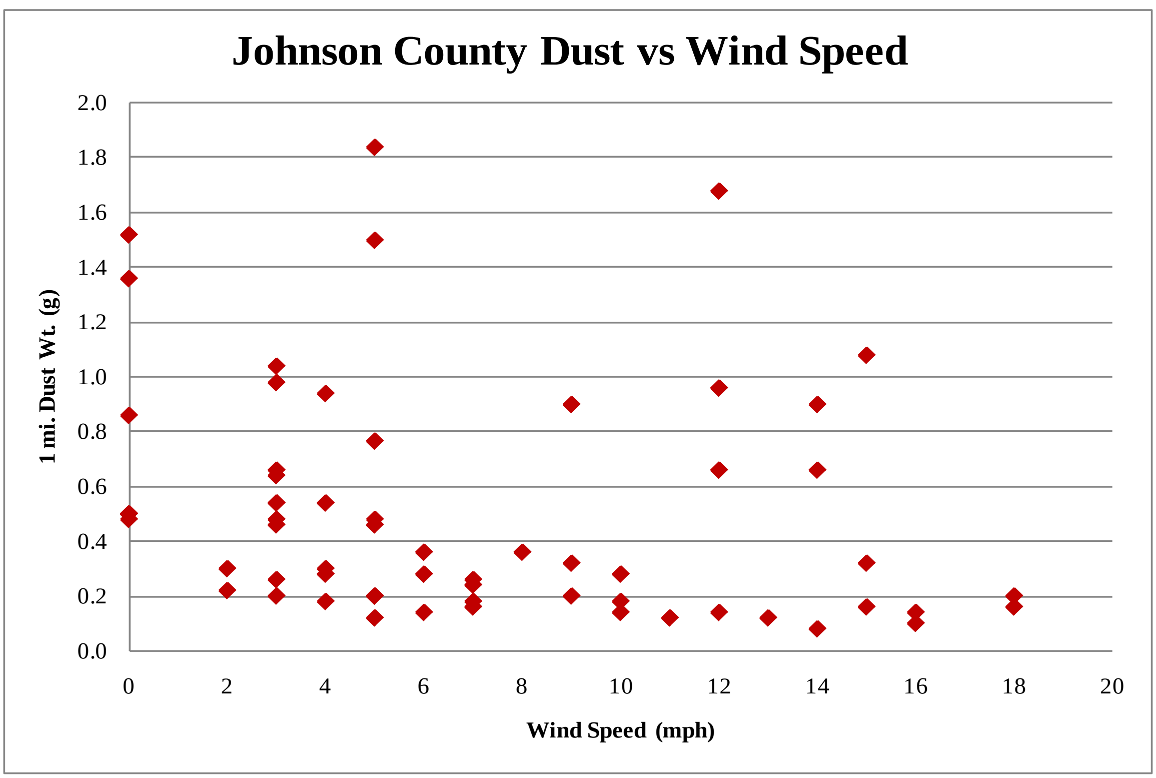
Johnson County Dust, Moisture Content, and Wind Data						
#	Test Section	Date of Sample	Time of Sample	Wind (mph)	1 mi. Dust Wt. (g)	Moisture Content (%)
51	Schoonover Road - S2 (RAP Blend)	10/3/2008	6:50 PM	12 SSE	0.96	0.326
52	Schoonover Road - S1 (RAP Blend w/ CaCl)	10/3/2008	7:05 PM	4 S	0.30	0.939
53	Schoonover Road - S0 (100% Gravel w/ CaCl)	10/3/2008	7:10 PM	4 S	0.54	1.980
54	Schoonover Road - S2 (RAP Blend)	10/3/2008	7:25 PM	7 S	0.26	0.326
55	Schoonover Road - S1 (RAP Blend w/ CaCl)	10/3/2008	7:20 PM	6 S	0.20	0.939
56	Schoonover Road - S0 (100% Gravel w/ CaCl)	10/3/2008	7:15 PM	5 S	0.28	1.980
57	Schoonover Road - S2 (RAP Blend)	10/4/2008	8:00 AM	4 S	0.94	0.844
58	Schoonover Road - S1 (RAP Blend w/ CaCl)	10/4/2008	8:20 AM	7 SSE	0.16	0.376
59	Schoonover Road - S0 (100% Gravel w/ CaCl)	10/4/2008	8:25 AM	9 S	0.32	1.713
60	Schoonover Road - S2 (RAP Blend)	10/4/2008	9:20 AM	16 S	0.10	0.844
61	Schoonover Road - S1 (RAP Blend w/ CaCl)	10/4/2008	9:10 AM	14 S	0.08	0.376
62	Schoonover Road - S0 (100% Gravel w/ CaCl)	10/4/2008	8:50 AM	12 S	0.14	1.713

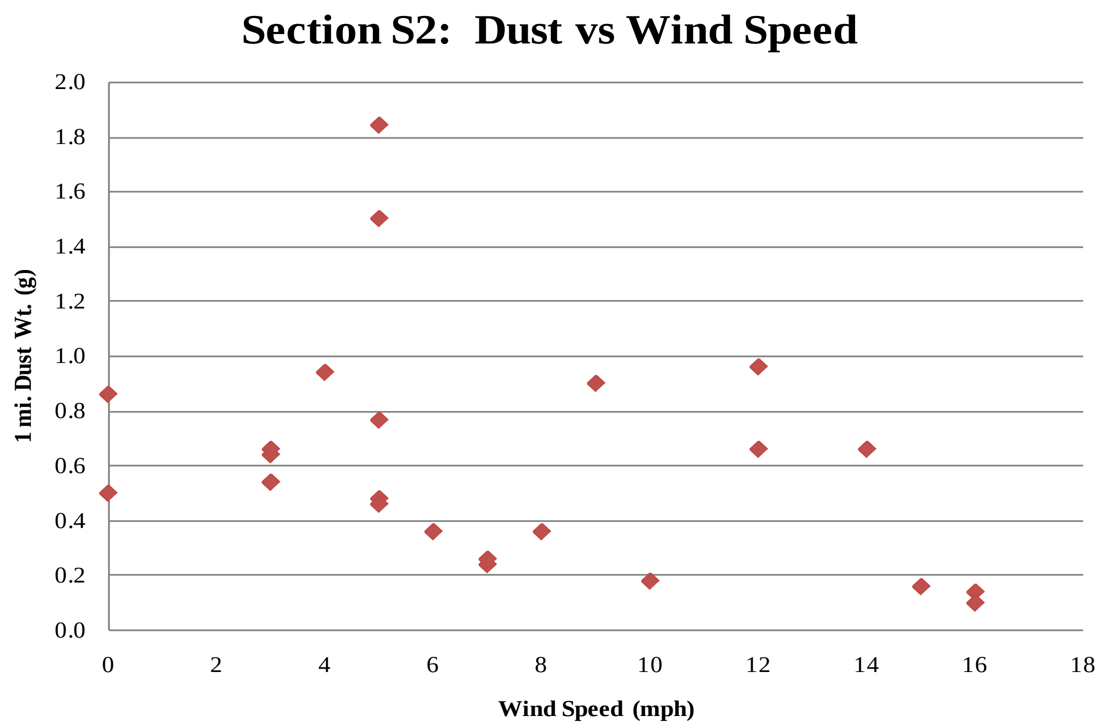


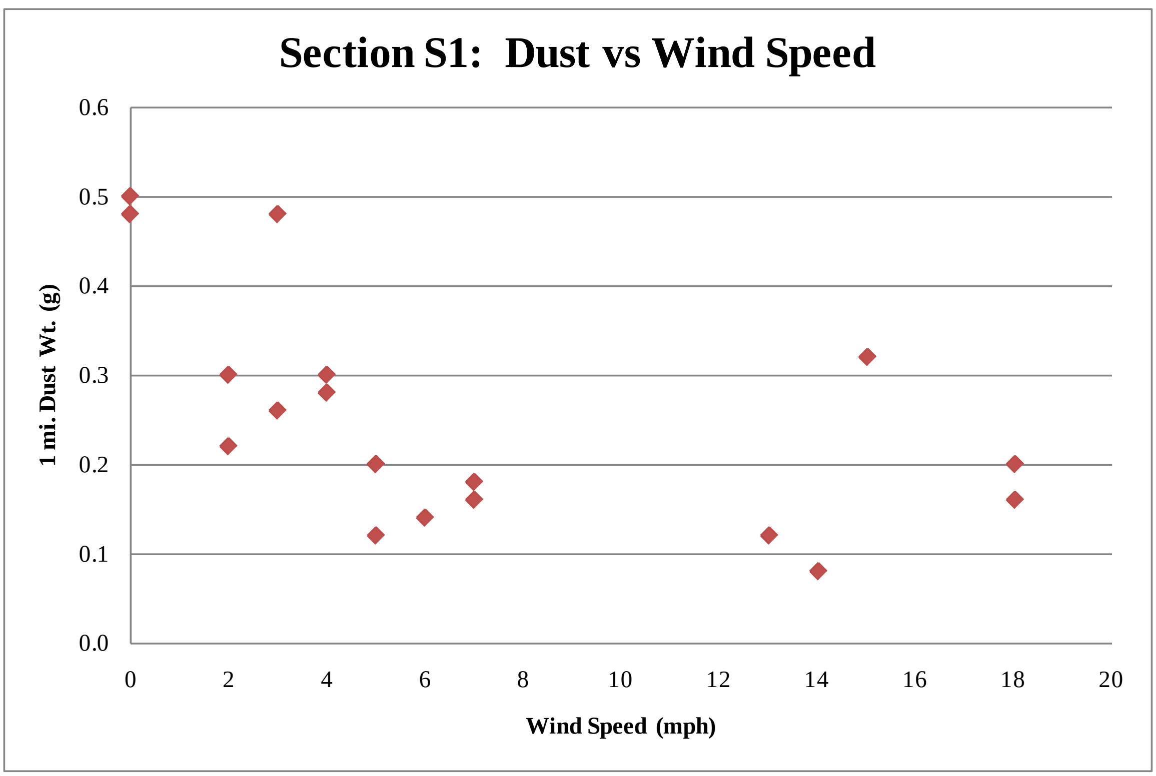

Section S2: Dust Wt. vs Age
1 mi. Dust Wt. (g)
2.0
1.8
1.6
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.0
0
20
40
60
80
100
120
Age (Days)

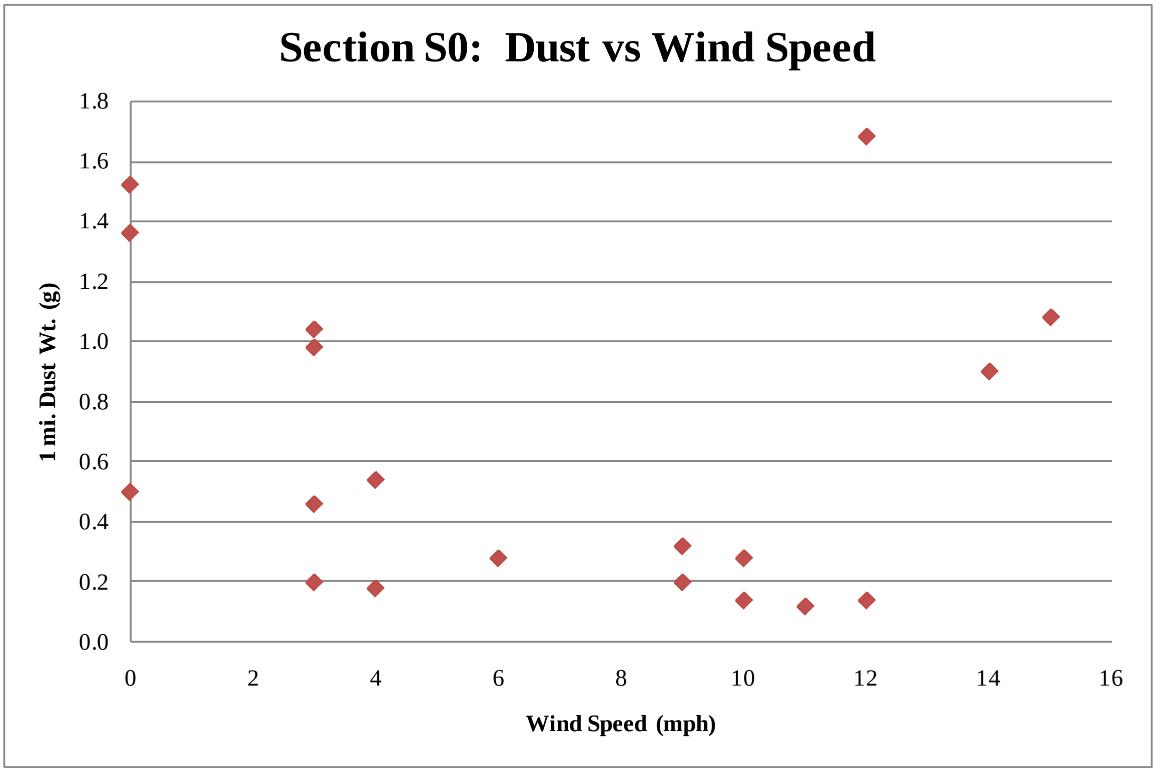

Section S1: Dust Wt. vs Age
1 mi. Dust Wt. (g)
0.6
0.5
0.4
0.3
0.2
0.1
0.0
0
20
40
60
80
Age (Days)

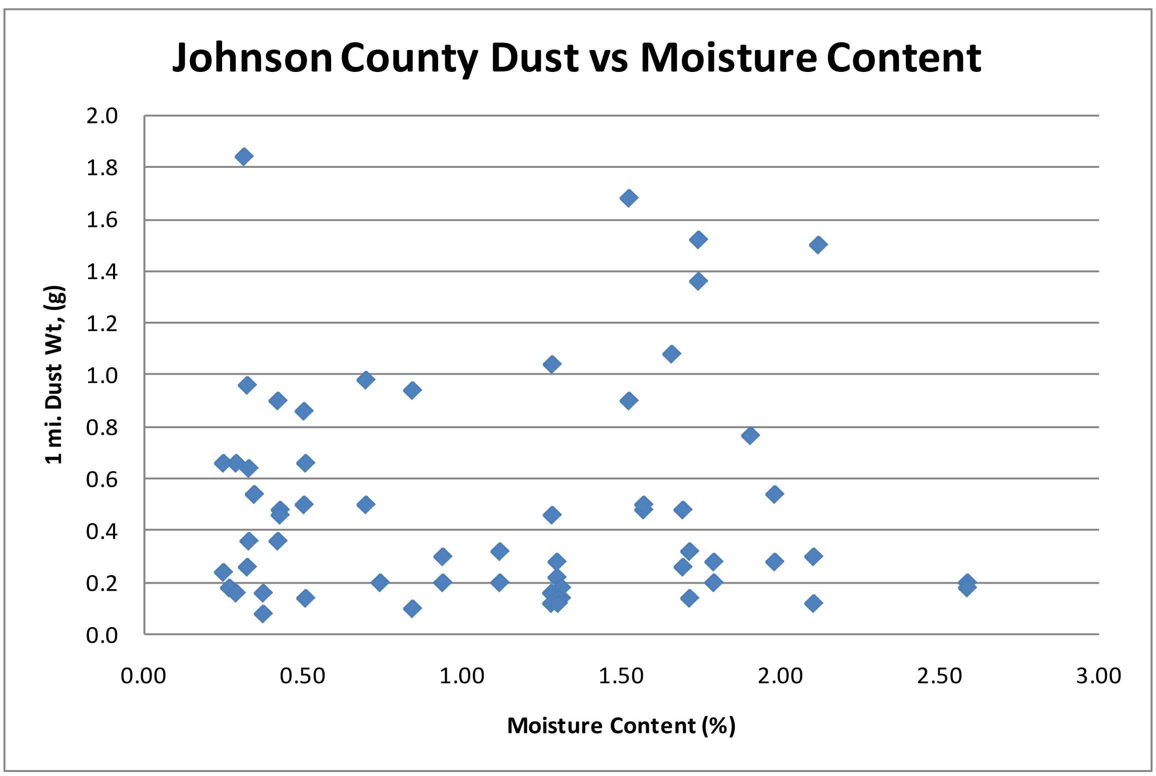

Section S0: Dust Wt. vs Age
1 mi. Dust Wt. (g)
1.8
1.6
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.0
0
20
40
60
80
100
Age (Days)

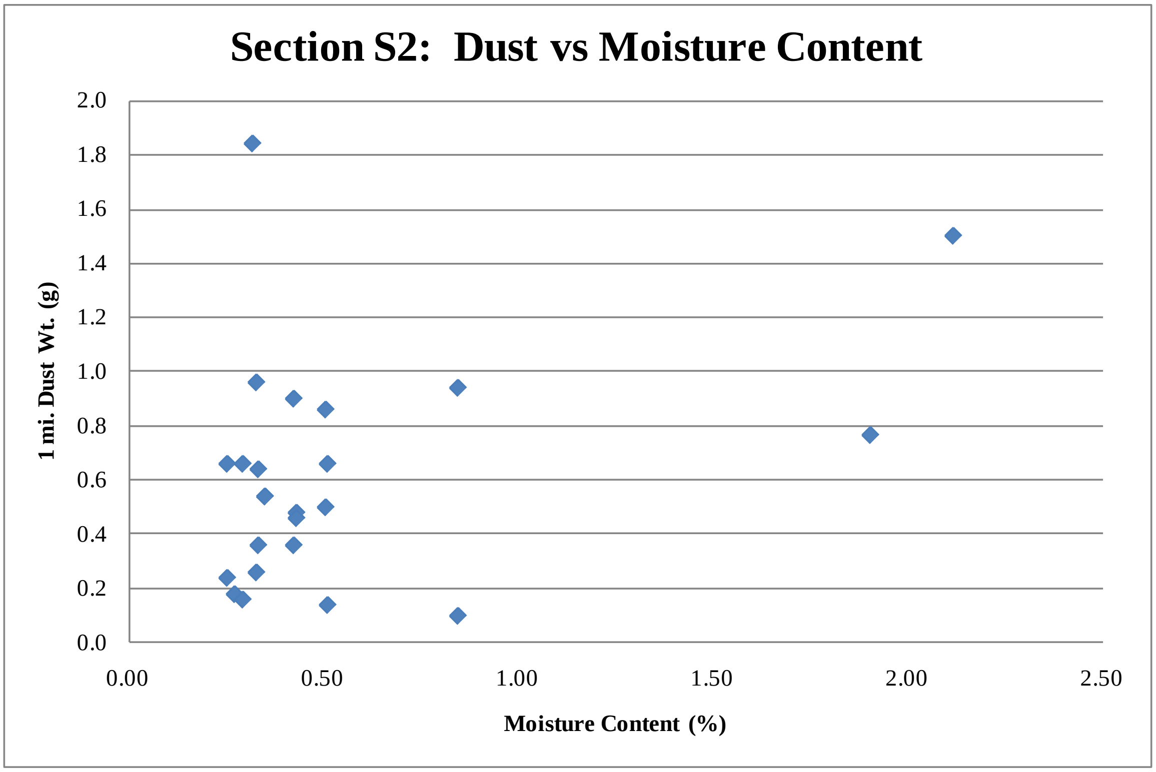

Johnson County Dust vs Wind Speed
1 mi. Dust Wt. (g)
2.0
1.8
1.6
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.0
0
2
4
6
8
10
12
14
16
18
20
Wind Speed (mph)

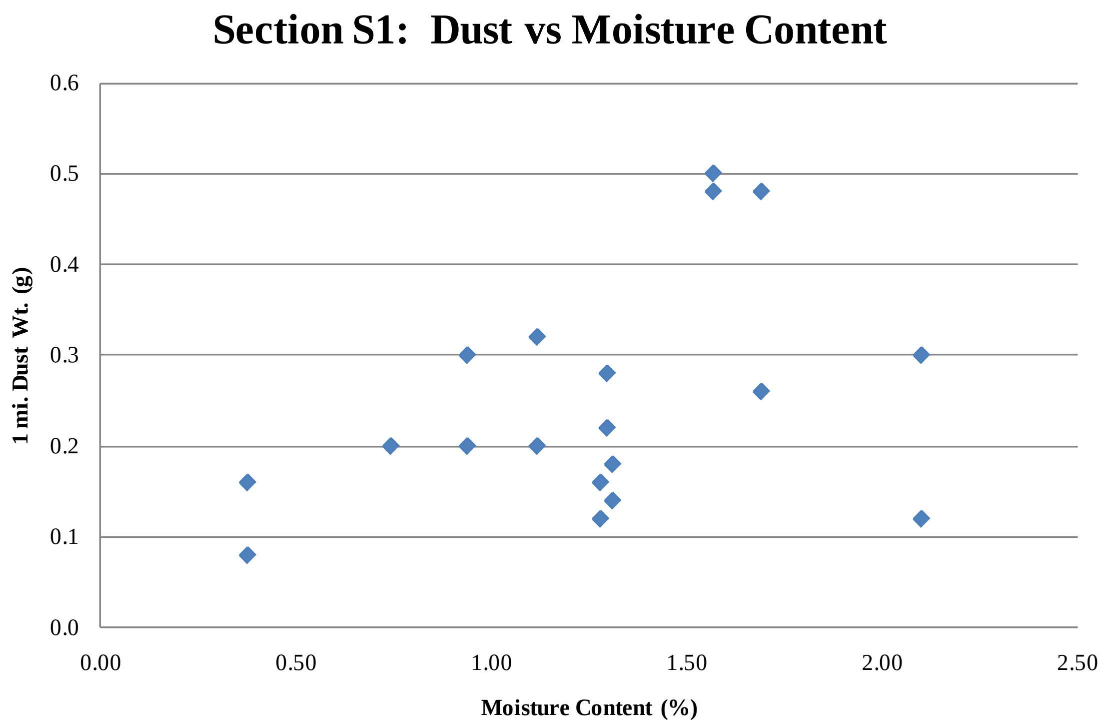

Section S2: Dust vs Wind Speed
2.0
1.8
1.6
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.0
1 mi. Dust Wt. (g)
0
2
4
6
8
10
12
14
16
18
Wind Speed (mph)

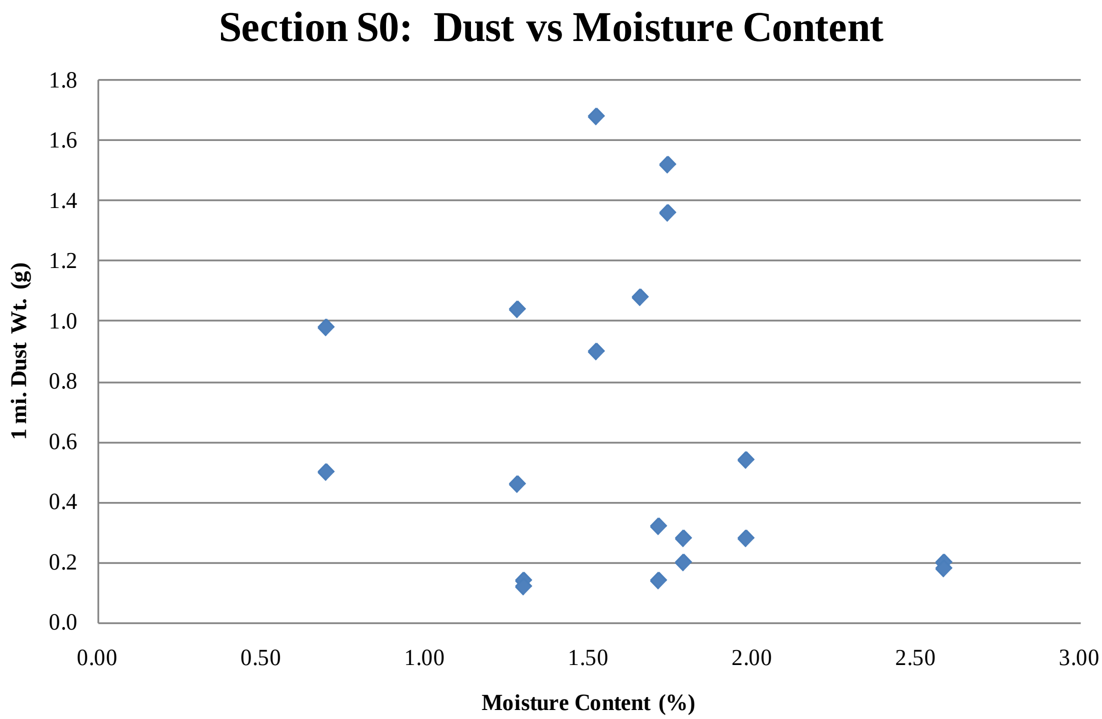

Section S1: Dust vs Wind Speed
0.6
0.5
0.4
0.3
0.2
0.1
0.0
1 mi. Dust Wt. (g)
0
2
4
6
8
10
12
14
16
18
20
Wind Speed (mph)


Section S0: Dust vs Wind Speed
1 mi. Dust Wt. (g)
1.8
1.6
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.0
0
2
4
6
8
10
12
14
16
Wind Speed (mph)


Johnson County Dust vs Moisture Content
1 mi. Dust Wt, (g)
2.0
1.8
1.6
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.0
0.00
0.50
1.00
1.50
2.00
2.50
3.00
Moisture Content (%)


Section S2: Dust vs Moisture Content
1 mi. Dust Wt. (g)
2.0
1.8
1.6
1.4
1.2
1.0
0.8
0.6
0.4
0.2
0.0
0.00
0.50
1.00
1.50
2.00
2.50
Moisture Content (%)


Section S1: Dust vs Moisture Content
1 mi. Dust Wt. (g)
0.6
0.5
0.4
0.3
0.2
0.1
0.0
0.00
0.50
1.00
1.50
2.00
2.50
Moisture Content (%)



Section S0: Dust vs Moisture Content
1 mi. Dust Wt. (g)
Moisture Content (%)
0.0
0.2
0.4
0.6
0.8
1.0
1.2
1.4
1.6
1.8
0.00
0.50
1.00
1.50
2.00
2.50
3.00

APPENDIX B

UNSURFACED ROAD CONDITION INDEX INSPECTION SHEETS

Laramie County URCI

Atlas Road - A2 (2 1/2" RAP)	
Date	URCI
6/24/2008	86
7/11/2008	84
7/28/2008	89
8/6/2008	82
8/13/2008	84
8/22/2008	77
9/5/2008	77
9/18/2008	76
10/4/2008	83

Pry Road - P1 (1 1/2" RAP)	
Date	URCI
6/24/2008	95
7/11/2008	95
7/28/2008	90
8/6/2008	90
8/13/2008	90
8/22/2008	90
9/5/2008	90
9/18/2008	91
10/4/2008	85

Atlas Road - A1 (1 1/2" RAP)	
Date	URCI
6/24/2008	100
7/11/2008	97
7/28/2008	92
8/6/2008	90
8/13/2008	90
8/22/2008	90
9/5/2008	90
9/18/2008	90
10/4/2008	90

Pry Road - P0 (100% Gravel)	
Date	URCI
6/24/2008	100
7/11/2008	100
7/28/2008	100
8/6/2008	100
8/13/2008	100
8/22/2008	100
9/5/2008	100
9/18/2008	100
10/4/2008	100

Atlas Road - A0 (100% Gravel)	
Date	URCI
6/24/2008	100
7/11/2008	100
7/28/2008	100
8/6/2008	100
8/13/2008	100
8/22/2008	93
9/5/2008	93
9/18/2008	94
10/4/2008	97

Johnson County URCI	
Schoonover Road - S2 (RAP Blend)	
Date	URCI
7/14/2008	100
7/29/2008	95
8/6/2008	95
8/13/2008	95
8/21/2008	92
9/1/2008	90
10/4/2008	88
Schoonover Road - S1 (RAP Blend w/ CaCl)	
Date	URCI
7/14/2008	100
7/29/2008	100
8/6/2008	90
8/13/2008	87
8/21/2008	87
9/1/2008	84
10/4/2008	88
Schoonover Road - S0 (100% Gravel w/ CaCl)	
Date	URCI
7/14/2008	100
7/29/2008	97
8/6/2008	90
8/21/2008	85
9/1/2008	83
10/4/2008	65

UNSURFACED ROAD INSPECTION SHEET

Branch	Atlas Road - A2	**Date**	6/24/2008
Section	2 1/2" RAP	**Inspector**	SK & GH
Sample Unit		**Area of Sample**	29' x 517 ' = 14993 sf

DISTRESS TYPES

1. Improper Cross Section (linear feet)
2. Inadequate Roadside Drainage (linear feet)
3. Corrugations (square feet)
4. Dust
5. Potholes (number)
6. Ruts (square feet)
7. Loose Aggregate (linear feet)

DISTRESS QUANTITY AND SEVERITY

Type		1	2	3	4	5	6	7
Quantity and Severity	L		130'				280 sf	727'
	M							30'
	H							

URCI CALCULATION

Distress Type	Density	Severity	Deduct Value
2	1.0%	L	2
6	1.9%	L	3
7	4.8%	L	8
7	0.2%	M	1
		Total Deduct Value =	14
		q =	1
URCI = 86		**Rating =**	EXC.

REMARKS:

- 1-2 % Cross Slope, peak not on centerline
- 8' x 35' = 280 sf of low rutting
- 100' of low severity drainage on north side
- 30' of low severity drainage on south side
- Total of 727' of low loose aggregate
- Total of 30' of medium loose aggregate

UNSURFACED ROAD INSPECTION SHEET

Branch	Atlas Road - A2	**Date**	7/11/2008
Section	2 1/2" RAP	**Inspector**	SK
Sample Unit		**Area of Sample**	29' x 517 ' = 14993 sf

DISTRESS TYPES

1. Improper Cross Section (linear feet)
2. Inadequate Roadside Drainage (linear feet)
3. Corrugations (square feet)
4. Dust
5. Potholes (number)
6. Ruts (square feet)
7. Loose Aggregate (linear feet)

DISTRESS QUANTITY AND SEVERITY

Type		1	2	3	4	5	6	7
Quantity and Severity	L		170'				440 sf	460'
	M						450 sf	70'
	H							40'

URCI CALCULATION

Distress Type	Density	Severity	Deduct Value
2	1.1%	L	2
6	2.9%	L	4
6	3.0%	M	5
7	3.1%	L	6
7	0.5%	M	2
7	0.3%	H	2
		Total Deduct Value =	21
		q =	2
URCI = 84		**Rating =**	Very Good

REMARKS:

- 1-2 % Cross Slope, peak not on centerline
- secondary shoulders starting to form in some spots
- 6" berm on south side 50' long with rutting
- 170 total' of low severity drainage
- Total of 460' of low loose aggregate
- Total of 70' of medium loose aggregate
- Total of 40' of high loose aggregate
- Low and Medium severity rutting also present

UNSURFACED ROAD INSPECTION SHEET

Branch	Atlas Road - A2	**Date**	7/28/2008
Section	2 1/2" RAP	**Inspector**	SK
Sample Unit		**Area of Sample**	29' x 517 ' = 14993 sf

DISTRESS TYPES

1. Improper Cross Section (linear feet)
2. Inadequate Roadside Drainage (linear feet)
3. Corrugations (square feet)
4. Dust
5. Potholes (number)
6. Ruts (square feet)
7. Loose Aggregate (linear feet)

DISTRESS QUANTITY AND SEVERITY

Type		1	2	3	4	5	6	7
Quantity and Severity	L						60 sf	755'
	M							15
	H							

URCI CALCULATION

Distress Type	Density	Severity	Deduct Value
7	5.0%	L	9
7	0.1%	M	1
6	0.4%	L	1
		Total Deduct Value =	11
		q =	1
URCI = 89		**Rating =**	EXC.

REMARKS:

• 1-2 % Cross Slope, flat center

• 755 ' of low loose aggregate
1/2" - 1 3/4"

• 15' of medium loose aggregate
2"

3' x 20' = 60 sf low rutting on south side

• Seems roadway has been reworked since last evaluation

UNSURFACED ROAD INSPECTION SHEET

Branch	Atlas Road - A2	**Date**	8/6/2008
Section	2 1/2" RAP	**Inspector**	SK
Sample Unit		**Area of Sample**	29' x 517 ' = 14993 sf

DISTRESS TYPES

1. Improper Cross Section (linear feet)
2. Inadequate Roadside Drainage (linear feet)
3. Corrugations (square feet)
4. Dust
5. Potholes (number)
6. Ruts (square feet)
7. Loose Aggregate (linear feet)

DISTRESS QUANTITY AND SEVERITY

Type		1	2	3	4	5	6	7
Quantity and Severity	L						220 sf	1059'
	M						200 sf	50'
	H							

URCI CALCULATION

Distress Type	Density	Severity	Deduct Value
7	7.1%	L	12
7	0.3%	M	3
6	1.5%	L	2
6	1.3%	M	2
		Total Deduct Value =	19
		q =	1
URCI = 82		**Rating =**	Very Good

REMARKS:

• 1-2 % Cross Slope, peak not on centerline
flat center

• Medium rutting on south side
4' x 50' = 200 sf

• Low rutting on south side
4' x 30' = 120 sf

• Low rutting on north side
2' x 50' = 100 sf

• Total of 1059' of low loose aggregate

• 50' of medium loose aggregate on south side

UNSURFACED ROAD INSPECTION SHEET

Branch	Atlas Road - A2	**Date**	8/13/2008
Section	2 1/2" RAP	**Inspector**	SK
Sample Unit		**Area of Sample**	29' x 517 ' = 14993 sf

DISTRESS TYPES

1. Improper Cross Section (linear feet)
2. Inadequate Roadside Drainage (linear feet)
3. Corrugations (square feet)
4. Dust
5. Potholes (number)
6. Ruts (square feet)
7. Loose Aggregate (linear feet)

DISTRESS QUANTITY AND SEVERITY

Type		1	2	3	4	5	6	7
Quantity and Severity	L						220 sf	1064'
	M						200 sf	100'
	H							

URCI CALCULATION

Distress Type	Density	Severity	Deduct Value
6	1.5%	L	2
6	1.3%	M	2
7	7.1%	L	12
7	0.7%	M	5
		Total Deduct Value =	21
		q =	2
URCI = 84		**Rating =**	Very Good

REMARKS:

- 1% Cross Slope not on centerline. Flat center
- Total of 1064' low loose aggregate
- 100' of medium loose aggregate on south side
- 200 sf of medium rutting on south side
- 120 sf of low rutting on south side
- 100 sf of low rutting on north side

UNSURFACED ROAD INSPECTION SHEET

Branch Atlas Road - A2 **Date** 8/22/2008
Section 2 1/2" RAP **Inspector** SK
Sample Unit **Area of Sample** 29' x 517 ' = 14993 sf

DISTRESS TYPES

1. Improper Cross Section (linear feet)
2. Inadequate Roadside Drainage (linear feet)
3. Corrugations (square feet)
4. Dust
5. Potholes (number)
6. Ruts (square feet)
7. Loose Aggregate (linear feet)

DISTRESS QUANTITY AND SEVERITY

Type		1	2	3	4	5	6	7
Quantity and Severity	L					10	250 sf	1064'
	M						400 sf	130'
	H							

URCI CALCULATION

Distress Type	Density	Severity	Deduct Value
6	1.7%	L	2
6	2.7%	M	3
7	7.1%	L	12
7	0.9%	M	4
5	0.07%	L	10
		Total Deduct Value =	23
		q =	1
URCI = 77		**Rating =**	Very Good

REMARKS:

- 1% Cross Slope not on centerline. Flat center
- Total of 1064' low loose aggregate
- 80' of medium loose aggregate on south side (east)
- 50' of medium loose aggregate on south side (west)
- Low and medium rutting on south side (east and west)
- >1' diameter potholes on west end

10 at 1" deep

UNSURFACED ROAD INSPECTION SHEET

Branch	Atlas Road - A2	**Date**	9/5/2008
Section	2 1/2" RAP	**Inspector**	SK
Sample Unit		**Area of Sample**	29' x 517 ' = 14993 sf

DISTRESS TYPES

1. Improper Cross Section (linear feet)
2. Inadequate Roadside Drainage (linear feet)
3. Corrugations (square feet)
4. Dust
5. Potholes (number)
6. Ruts (square feet)
7. Loose Aggregate (linear feet)

DISTRESS QUANTITY AND SEVERITY

Type		1	2	3	4	5	6	7
Quantity and Severity	L					10	250 sf	1034'
	M						400 sf	300'
	H							

URCI CALCULATION

Distress Type	Density	Severity	Deduct Value
5	0.07%	L	2
6	1.7%	L	2
6	2.7%	M	3
7	7.1%	L	12
7	2.0%	M	10
		Total Deduct Value =	29
		q =	2
URCI = 77		**Rating =**	Very Good

REMARKS:

- 1% Cross Slope not on centerline. Flat center
- 1034' low loose aggregate from both sides
- 300' med loose aggregate on south side

- 80' x 4' = 320sf of medium rutting on south side
- 30' x 3' = 90sf of low rutting (middle) (west)
- 40' x 4' = 160 sf low rutting south (east)
- 20' x 4' = 80 sf medium rutting north (west)

- >1' diameter potholes on west end 10 at 1" deep

UNSURFACED ROAD INSPECTION SHEET

Branch	Atlas Road - A2	**Date**	9/18/2008
Section	2 1/2" RAP	**Inspector**	SK
Sample Unit		**Area of Sample**	29' x 517 ' = 14993 sf

DISTRESS TYPES

1. Improper Cross Section (linear feet)
2. Inadequate Roadside Drainage (linear feet)
3. Corrugations (square feet)
4. Dust
5. Potholes (number)
6. Ruts (square feet)
7. Loose Aggregate (linear feet)

DISTRESS QUANTITY AND SEVERITY

Type		1	2	3	4	5	6	7
Quantity and Severity	L					10	320 sf	1264'
	M						300 sf	45'
	H							30'

URCI CALCULATION

Distress Type	Density	Severity	Deduct Value
5	0.07%	L	2
6	1.7%	L	2
6	2.7%	M	3
7	7.1%	L	12
7	0.3%	M	2
7	0.2%	H	2
		Total Deduct Value =	22
		q =	1
URCI = 79		**Rating =**	Very Good

REMARKS:

- 1% Cross Slope not on centerline. Flat center
- 1034' low loose aggregate from both sides
- 30' low loose aggregate middle (west)
- 200' low loose aggregate middle(east)
- 45' med loose aggregate south (east)
- 30' high loose aggregate south (east)

- 35' x 4' = 140 sf low rutting middle (west)
- 60' x 3' = 180 sf low rutting middle (east)
- 50' x 6' = 300 sf med rutting middle (east)
- >1' diameter potholes on west end

10 at 1" deep

UNSURFACED ROAD INSPECTION SHEET

Branch	Atlas Road - A2	**Date**	10/4/2008
Section	2 1/2" RAP	**Inspector**	SK
Sample Unit		**Area of Sample**	29' x 517 ' = 14993 sf

DISTRESS TYPES

1. Improper Cross Section (linear feet)
2. Inadequate Roadside Drainage (linear feet)
3. Corrugations (square feet)
4. Dust
5. Potholes (number)
6. Ruts (square feet)
7. Loose Aggregate (linear feet)

DISTRESS QUANTITY AND SEVERITY

Type		1	2	3	4	5	6	7
Quantity and Severity	L					10	625 sf	1134'
	M							
	H							30'

URCI CALCULATION

Distress Type	Density	Severity	Deduct Value
5	0.07%	L	2
6	4.2%	L	7
7	7.6%	L	12
7	0.2%	H	2
		Total Deduct Value =	23
		q =	2
URCI = 83		**Rating =**	Very Good

REMARKS:

- 1% Cross Slope not on centerline. Flat center
- 1034' low loose aggregate from both sides
< 2"
- 100' low loose aggregate middle(east)
- 30' high loose aggregate south (east)
- 30' x2' = 60 sf low rutting middle
- 45' x 3' = 135 sf low rutting middle (east)
- 50' x 5' = 250 sf med rutting middle (east)
- >1' diameter potholes on west end
10 at 1" deep

UNSURFACED ROAD INSPECTION SHEET

Branch	Atlas Road - A1	**Date**	6/24/2008
Section	1 1/2" RAP	**Inspector**	SK & GH
Sample Unit		**Area of Sample**	30' x 100 ' = 3000 sf

DISTRESS TYPES

1. Improper Cross Section (linear feet)
2. Inadequate Roadside Drainage (linear feet)
3. Corrugations (square feet)
4. Dust
5. Potholes (number)
6. Ruts (square feet)
7. Loose Aggregate (linear feet)

DISTRESS QUANTITY AND SEVERITY

Type		1	2	3	4	5	6	7
Quantity and Severity	L							
	M							
	H							

URCI CALCULATION

Distress Type	Density	Severity	Deduct Value
		Total Deduct Value =	0
		q =	0
URCI = 100		**Rating =**	EXC.

REMARKS:

- 3 % Cross Slope
- No Distresses

UNSURFACED ROAD INSPECTION SHEET

Branch	Atlas Road - A1	**Date**	7/11/2008
Section	1 1/2" RAP	**Inspector**	SK
Sample Unit		**Area of Sample**	3000 sf

DISTRESS TYPES

1. Improper Cross Section (linear feet)
2. Inadequate Roadside Drainage (linear feet)
3. Corrugations (square feet)
4. Dust
5. Potholes (number)
6. Ruts (square feet)
7. Loose Aggregate (linear feet)

DISTRESS QUANTITY AND SEVERITY

Type		1	2	3	4	5	6	7
Quantity and Severity	L							65'
	M							
	H							

URCI CALCULATION

Distress Type	Density	Severity	Deduct Value
7	2.2%	L	4
		Total Deduct Value =	4
		q =	0
URCI = 97		**Rating =**	EXC.

REMARKS:

- 3 % Cross Slope
- 40' of low loose aggregate on north side
- 25' of low loose aggregate on south side

1/2" - 3/4"

UNSURFACED ROAD INSPECTION SHEET

Branch Atlas Road - A1 **Date** 7/28/2008
Section 1 1/2" RAP **Inspector** SK
Sample Unit **Area of Sample** 3000 sf

DISTRESS TYPES

1. Improper Cross Section (linear feet)
2. Inadequate Roadside Drainage (linear feet)
3. Corrugations (square feet)
4. Dust
5. Potholes (number)
6. Ruts (square feet)
7. Loose Aggregate (linear feet)

DISTRESS QUANTITY AND SEVERITY

Type		1	2	3	4	5	6	7
Quantity and Severity	L							150'
	M							
	H							

URCI CALCULATION

Distress Type	Density	Severity	Deduct Value
7	5.0%	L	9
		Total Deduct Value =	9
		q =	1
URCI = 92		**Rating =**	EXC.

REMARKS:

- 2 % Cross Slope
- 100' of low loose aggregate on north side
- 50' of low loose aggregate on south side

1/2" - 1"

UNSURFACED ROAD INSPECTION SHEET

Branch	Atlas Road - A1	**Date**	8/6/2008
Section	1 1/2" RAP	**Inspector**	SK
Sample Unit		**Area of Sample**	3000 sf

DISTRESS TYPES

1. Improper Cross Section (linear feet)
2. Inadequate Roadside Drainage (linear feet)
3. Corrugations (square feet)
4. Dust
5. Potholes (number)
6. Ruts (square feet)
7. Loose Aggregate (linear feet)

DISTRESS QUANTITY AND SEVERITY

Type		1	2	3	4	5	6	7
Quantity and Severity	L							200'
	M							
	H							

URCI CALCULATION

Distress Type	Density	Severity	Deduct Value
7	6.7%	L	11
		Total Deduct Value =	11
		q =	1
URCI = 90		**Rating =**	EXC.

REMARKS:

- 2 % Cross Slope
- 100' of low loose aggregate on north side 1/2" - 1"
- 100' of low loose aggregate on south side 1/2" - 1 1/4"

UNSURFACED ROAD INSPECTION SHEET

Branch	Atlas Road - A1	**Date**	8/13/2008
Section	1 1/2" RAP	**Inspector**	SK
Sample Unit		**Area of Sample**	3000 sf

DISTRESS TYPES

1. Improper Cross Section (linear feet)
2. Inadequate Roadside Drainage (linear feet)
3. Corrugations (square feet)
4. Dust
5. Potholes (number)
6. Ruts (square feet)
7. Loose Aggregate (linear feet)

DISTRESS QUANTITY AND SEVERITY

Type		1	2	3	4	5	6	7
Quantity and Severity	L							200'
	M							
	H							

URCI CALCULATION

Distress Type	Density	Severity	Deduct Value
7	6.7%	L	11
		Total Deduct Value =	11
		q =	1
URCI = 90		**Rating =**	EXC.

REMARKS:

- 2 % Cross Slope
- 100' of low loose aggregate on north side 1/2" - 1 1/4"
- 100' of low loose aggregate on south side 1/2" - 1 1/4"

UNSURFACED ROAD INSPECTION SHEET

Branch Atlas Road - A1
Section 1 1/2" RAP
Sample Unit

Date 8/22/2008
Inspector SK
Area of Sample 3000 sf

DISTRESS TYPES

1. Improper Cross Section (linear feet)
2. Inadequate Roadside Drainage (linear feet)
3. Corrugations (square feet)
4. Dust
5. Potholes (number)
6. Ruts (square feet)
7. Loose Aggregate (linear feet)

DISTRESS QUANTITY AND SEVERITY

Type		1	2	3	4	5	6	7
Quantity and Severity	L							200'
	M							
	H							

URCI CALCULATION

Distress Type	Density	Severity	Deduct Value
7	6.7%	L	11

Total Deduct Value = 11
q = 1
URCI = 90
Rating = EXC.

REMARKS:

- 2% Cross Slope
- 100' of low loose aggregate on north side 1/2" - 1 1/4"
- 100' of low loose aggregate on south side 1/2" - 1 1/4"
- no rutting but rough surface

UNSURFACED ROAD INSPECTION SHEET

Branch	Atlas Road - A1	**Date**	9/5/2008
Section	1 1/2" RAP	**Inspector**	SK
Sample Unit		**Area of Sample**	3000 sf

DISTRESS TYPES

1. Improper Cross Section (linear feet)
2. Inadequate Roadside Drainage (linear feet)
3. Corrugations (square feet)
4. Dust
5. Potholes (number)
6. Ruts (square feet)
7. Loose Aggregate (linear feet)

DISTRESS QUANTITY AND SEVERITY

Type		1	2	3	4	5	6	7
Quantity and Severity	L							200'
	M							
	H							

URCI CALCULATION

Distress Type	Density	Severity	Deduct Value
7	6.7%	L	11
		Total Deduct Value =	11
		q =	1
URCI = 90		**Rating =**	EXC.

REMARKS:

- 2% Cross Slope
- 100' of low loose aggregate on north side 3/4" - 1 1/4"
- 100' of low loose aggregate on south side 1/2" - 1 1/4"

UNSURFACED ROAD INSPECTION SHEET

Branch	Atlas Road - A1	**Date**	9/18/2008
Section	1 1/2" RAP	**Inspector**	SK
Sample Unit		**Area of Sample**	3000 sf

DISTRESS TYPES

1. Improper Cross Section (linear feet)
2. Inadequate Roadside Drainage (linear feet)
3. Corrugations (square feet)
4. Dust
5. Potholes (number)
6. Ruts (square feet)
7. Loose Aggregate (linear feet)

DISTRESS QUANTITY AND SEVERITY

Type		1	2	3	4	5	6	7
Quantity and Severity	L							200'
	M							
	H							

URCI CALCULATION

Distress Type	Density	Severity	Deduct Value
7	6.7%	L	11
		Total Deduct Value =	11
		q =	1
URCI = 90		**Rating =**	EXC.

REMARKS:

- 2% Cross Slope
- 100' of low loose aggregate on both sides

3/4" - 1 1/2"

UNSURFACED ROAD INSPECTION SHEET

Branch	Atlas Road - A1	**Date**	10/4/2008
Section	1 1/2" RAP	**Inspector**	SK
Sample Unit		**Area of Sample**	3000 sf

DISTRESS TYPES

1. Improper Cross Section (linear feet)
2. Inadequate Roadside Drainage (linear feet)
3. Corrugations (square feet)
4. Dust
5. Potholes (number)
6. Ruts (square feet)
7. Loose Aggregate (linear feet)

DISTRESS QUANTITY AND SEVERITY

Type		1	2	3	4	5	6	7
Quantity and Severity	L							200'
	M							
	H							

URCI CALCULATION

Distress Type	Density	Severity	Deduct Value
7	6.7%	L	11
		Total Deduct Value =	11
		q =	1
URCI = 90		**Rating =**	EXC.

REMARKS:

- 2% Cross Slope
- 100' of low loose aggregate on both sides

3/4" - 1 1/2"

UNSURFACED ROAD INSPECTION SHEET

Branch	Atlas Road - A0	**Date**	6/24/2008
Section	100 % Gravel	**Inspector**	SK & GH
Sample Unit		**Area of Sample**	27' x 100 ' = 2700 sf

DISTRESS TYPES

1. Improper Cross Section (linear feet)
2. Inadequate Roadside Drainage (linear feet)
3. Corrugations (square feet)
4. Dust
5. Potholes (number)
6. Ruts (square feet)
7. Loose Aggregate (linear feet)

DISTRESS QUANTITY AND SEVERITY

Type		1	2	3	4	5	6	7
Quantity and Severity	L							
	M							
	H							

URCI CALCULATION

Distress Type	Density	Severity	Deduct Value
		Total Deduct Value =	0
		q =	0
URCI = 100		**Rating =**	EXC.

REMARKS:

- 2 % Cross Slope
- No Distresses

UNSURFACED ROAD INSPECTION SHEET

Branch	Atlas Road - A0	**Date**	7/11/2008
Section	100 % Gravel	**Inspector**	SK
Sample Unit		**Area of Sample**	27' x 100 ' = 2700 sf

DISTRESS TYPES

1. Improper Cross Section (linear feet)
2. Inadequate Roadside Drainage (linear feet)
3. Corrugations (square feet)
4. Dust
5. Potholes (number)
6. Ruts (square feet)
7. Loose Aggregate (linear feet)

DISTRESS QUANTITY AND SEVERITY

Type		1	2	3	4	5	6	7
Quantity and Severity	L							
	M							
	H							

URCI CALCULATION

Distress Type	Density	Severity	Deduct Value
		Total Deduct Value =	0
		q =	0
URCI = 100		Rating =	EXC.

REMARKS:

- 2 % Cross Slope
- No Distresses

UNSURFACED ROAD INSPECTION SHEET

Branch	Atlas Road - A0	**Date**	7/28/2008
Section	100 % Gravel	**Inspector**	SK
Sample Unit		**Area of Sample**	27' x 100 ' = 2700 sf

DISTRESS TYPES

1. Improper Cross Section (linear feet)
2. Inadequate Roadside Drainage (linear feet)
3. Corrugations (square feet)
4. Dust
5. Potholes (number)
6. Ruts (square feet)
7. Loose Aggregate (linear feet)

DISTRESS QUANTITY AND SEVERITY

Type		1	2	3	4	5	6	7
Quantity and Severity	L							
	M							
	H							

URCI CALCULATION

Distress Type	Density	Severity	Deduct Value
		Total Deduct Value =	0
		q =	0
URCI = 100		**Rating =**	EXC.

REMARKS:

- 2 % Cross Slope
- No Distresses

UNSURFACED ROAD INSPECTION SHEET

Branch	Atlas Road - A0	**Date**	8/6/2008
Section	100 % Gravel	**Inspector**	SK
Sample Unit		**Area of Sample**	27' x 100 ' = 2700 sf

DISTRESS TYPES

1. Improper Cross Section (linear feet)
2. Inadequate Roadside Drainage (linear feet)
3. Corrugations (square feet)
4. Dust
5. Potholes (number)
6. Ruts (square feet)
7. Loose Aggregate (linear feet)

DISTRESS QUANTITY AND SEVERITY

Type		1	2	3	4	5	6	7
Quantity and Severity	L							
	M							
	H							

URCI CALCULATION

Distress Type	Density	Severity	Deduct Value
		Total Deduct Value =	0
		q =	0
URCI = 100		**Rating =**	EXC.

REMARKS:

- 2 % Cross Slope
- No Distresses

UNSURFACED ROAD INSPECTION SHEET

Branch	Atlas Road - A0	**Date**	8/13/2008
Section	100 % Gravel	**Inspector**	SK
Sample Unit		**Area of Sample**	27' x 100 ' = 2700 sf

DISTRESS TYPES

1. Improper Cross Section (linear feet)
2. Inadequate Roadside Drainage (linear feet)
3. Corrugations (square feet)
4. Dust
5. Potholes (number)
6. Ruts (square feet)
7. Loose Aggregate (linear feet)

DISTRESS QUANTITY AND SEVERITY

Type		1	2	3	4	5	6	7
Quantity and Severity	L							
	M							
	H							

URCI CALCULATION

Distress Type	Density	Severity	Deduct Value
		Total Deduct Value =	0
		q =	0
URCI = 100		**Rating =**	EXC.

REMARKS:

- 2 % Cross Slope
- No Distresses

UNSURFACED ROAD INSPECTION SHEET

Branch Atlas Road - A0 **Date** 8/22/2008
Section 100 % Gravel **Inspector** SK
Sample Unit **Area of Sample** 27' x 100 ' = 2700 sf

DISTRESS TYPES

1. Improper Cross Section (linear feet)
2. Inadequate Roadside Drainage (linear feet)
3. Corrugations (square feet)
4. Dust
5. Potholes (number)
6. Ruts (square feet)
7. Loose Aggregate (linear feet)

DISTRESS QUANTITY AND SEVERITY

Type		1	2	3	4	5	6	7
Quantity and Severity	L							100'
	M							
	H							

URCI CALCULATION

Distress Type	Density	Severity	Deduct Value
7	3.7%	L	8
		Total Deduct Value =	8
		q =	1
URCI = 93		**Rating =**	EXC.

REMARKS:

• 2 % Cross Slope

• 100' of low loose aggregate on south side 1/2" - 1"

UNSURFACED ROAD INSPECTION SHEET

Branch	Atlas Road - A0	**Date**	9/5/2008
Section	100 % Gravel	**Inspector**	SK
Sample Unit		**Area of Sample**	27' x 100 ' = 2700 sf

DISTRESS TYPES

1. Improper Cross Section (linear feet)
2. Inadequate Roadside Drainage (linear feet)
3. Corrugations (square feet)
4. Dust
5. Potholes (number)
6. Ruts (square feet)
7. Loose Aggregate (linear feet)

DISTRESS QUANTITY AND SEVERITY

Type		1	2	3	4	5	6	7
Quantity and Severity	L							100'
	M							
	H							

URCI CALCULATION

Distress Type	Density	Severity	Deduct Value
7	3.7%	L	8
		Total Deduct Value =	8
		q =	1
URCI = 93		**Rating =**	EXC.

REMARKS:

- 2 % Cross Slope
- 100' of low loose aggregate on south side 1/2" - 1"

UNSURFACED ROAD INSPECTION SHEET

Branch	Atlas Road - A0	**Date**	9/18/2008
Section	100 % Gravel	**Inspector**	SK
Sample Unit		**Area of Sample**	27' x 100 ' = 2700 sf

DISTRESS TYPES

1. Improper Cross Section (linear feet)
2. Inadequate Roadside Drainage (linear feet)
3. Corrugations (square feet)
4. Dust
5. Potholes (number)
6. Ruts (square feet)
7. Loose Aggregate (linear feet)

DISTRESS QUANTITY AND SEVERITY

Type		1	2	3	4	5	6	7
Quantity and Severity	L							80'
	M							
	H							

URCI CALCULATION

Distress Type	Density	Severity	Deduct Value
7	3.0%	L	6
		Total Deduct Value =	6
		q =	1
URCI = 94		**Rating =**	EXC.

REMARKS:

- 2 % Cross Slope
- 80' of low loose aggregate on south side 1/2" - 1"

UNSURFACED ROAD INSPECTION SHEET

Branch	Atlas Road - A0	**Date**	10/4/2008
Section	100 % Gravel	**Inspector**	SK
Sample Unit		**Area of Sample**	27' x 100 ' = 2700 sf

DISTRESS TYPES

1. Improper Cross Section (linear feet)
2. Inadequate Roadside Drainage (linear feet)
3. Corrugations (square feet)
4. Dust
5. Potholes (number)
6. Ruts (square feet)
7. Loose Aggregate (linear feet)

DISTRESS QUANTITY AND SEVERITY

Type		1	2	3	4	5	6	7
Quantity and Severity	L							55'
	M							
	H							

URCI CALCULATION

Distress Type	Density	Severity	Deduct Value
7	2.0%	L	4
		Total Deduct Value =	4
		q =	1
URCI = 97		**Rating =**	EXC.

REMARKS:

- 2 % Cross Slope
- 55' of low loose aggregate on south side 1/2" - 1"

UNSURFACED ROAD INSPECTION SHEET

Branch	Pry Road - P1	**Date**	6/24/2008
Section	1 1/2" RAP	**Inspector**	SK & GH
Sample Unit		**Area of Sample**	29' x 100 ' = 2900 sf

DISTRESS TYPES

1. Improper Cross Section (linear feet)
2. Inadequate Roadside Drainage (linear feet)
3. Corrugations (square feet)
4. Dust
5. Potholes (number)
6. Ruts (square feet)
7. Loose Aggregate (linear feet)

DISTRESS QUANTITY AND SEVERITY

Type		1	2	3	4	5	6	7
Quantity and Severity	L							100'
	M							
	H							

URCI CALCULATION

Distress Type	Density	Severity	Deduct Value
7	3.5%	L	6
		Total Deduct Value =	6
		q =	1
URCI = 95		**Rating =**	EXC.

REMARKS:

• 3 % Cross Slope

• 100' low loose aggregate on west side 1/2" - 3/4"

UNSURFACED ROAD INSPECTION SHEET

Branch Pry Road - P1 **Date** 7/11/2008
Section 1 1/2" RAP **Inspector** SK
Sample Unit **Area of Sample** 2900 sf

DISTRESS TYPES

1. Improper Cross Section (linear feet)
2. Inadequate Roadside Drainage (linear feet)
3. Corrugations (square feet)
4. Dust
5. Potholes (number)
6. Ruts (square feet)
7. Loose Aggregate (linear feet)

DISTRESS QUANTITY AND SEVERITY

Type		1	2	3	4	5	6	7
Quantity and Severity	L							100'
	M							
	H							

URCI CALCULATION

Distress Type	Density	Severity	Deduct Value
7	3.5%	L	6
		Total Deduct Value =	6
		q =	1
URCI = 95		**Rating =**	EXC.

REMARKS:

• 3 % Cross Slope

• 100' low loose aggregate on west side
1/2" - 3/4"

UNSURFACED ROAD INSPECTION SHEET

Branch	Pry Road - P1	**Date**	7/28/2008
Section	1 1/2" RAP	**Inspector**	SK
Sample Unit		**Area of Sample**	2900 sf

DISTRESS TYPES

1. Improper Cross Section (linear feet)
2. Inadequate Roadside Drainage (linear feet)
3. Corrugations (square feet)
4. Dust
5. Potholes (number)
6. Ruts (square feet)
7. Loose Aggregate (linear feet)

DISTRESS QUANTITY AND SEVERITY

Type		1	2	3	4	5	6	7
Quantity and Severity	L							200'
	M							
	H							

URCI CALCULATION

Distress Type	Density	Severity	Deduct Value
7	6.9%	L	11
		Total Deduct Value =	11
		q =	1
URCI = 90		**Rating =**	EXC.

REMARKS:

- 3 % Cross Slope
- 100' low loose aggregate on west side 3/4" - 1 1/4"
- 100' low loose aggregate on east side 1/2" - 1"

UNSURFACED ROAD INSPECTION SHEET

Branch Pry Road - P1 **Date** 8/6/2008
Section 1 1/2" RAP **Inspector** SK
Sample Unit **Area of Sample** 2900 sf

DISTRESS TYPES
1. Improper Cross Section (linear feet)
2. Inadequate Roadside Drainage (linear feet)
3. Corrugations (square feet)
4. Dust
5. Potholes (number)
6. Ruts (square feet)
7. Loose Aggregate (linear feet)

DISTRESS QUANTITY AND SEVERITY

Type		1	2	3	4	5	6	7
Quantity and Severity	L							200'
	M							
	H							

URCI CALCULATION

Distress Type	Density	Severity	Deduct Value
7	6.9%	L	11
		Total Deduct Value =	11
		q =	1
URCI = 90		**Rating =**	EXC.

REMARKS:

• 3 % Cross Slope

• 100' low loose aggregate on west side
3/4" - 1"

• 100' low loose aggregate on east side
1/2" - 1"

UNSURFACED ROAD INSPECTION SHEET

Branch Pry Road - P1
Section 1 1/2" RAP
Sample Unit

Date 8/13/2008
Inspector SK
Area of Sample 2900 sf

DISTRESS TYPES

1. Improper Cross Section (linear feet)
2. Inadequate Roadside Drainage (linear feet)
3. Corrugations (square feet)
4. Dust
5. Potholes (number)
6. Ruts (square feet)
7. Loose Aggregate (linear feet)

DISTRESS QUANTITY AND SEVERITY

Type		1	2	3	4	5	6	7
Quantity and Severity	L							200'
	M							
	H							

URCI CALCULATION

Distress Type	Density	Severity	Deduct Value
7	6.9%	L	11
		Total Deduct Value =	11
		q =	1
URCI = 90		**Rating =**	EXC.

REMARKS:

• 3 % Cross Slope

• 100' low loose aggregate on west side 1/2" - 1"

• 100' low loose aggregate on east side 1/2" - 1"

UNSURFACED ROAD INSPECTION SHEET

Branch Pry Road - P1
Section 1 1/2" RAP
Sample Unit

Date 8/22/2008
Inspector SK
Area of Sample 2900 sf

DISTRESS TYPES

1. Improper Cross Section (linear feet)
2. Inadequate Roadside Drainage (linear feet)
3. Corrugations (square feet)
4. Dust
5. Potholes (number)
6. Ruts (square feet)
7. Loose Aggregate (linear feet)

DISTRESS QUANTITY AND SEVERITY

Type		1	2	3	4	5	6	7
Quantity and Severity	L							200'
	M							
	H							

URCI CALCULATION

Distress Type	Density	Severity	Deduct Value
7	6.9%	L	11
		Total Deduct Value =	11
		q =	1
URCI = 90		Rating =	EXC.

REMARKS:

- 3 % Cross Slope
- 100' low loose aggregate on west side
3/4" - 1"
- 100' low loose aggregate on east side
3/4" - 1"

UNSURFACED ROAD INSPECTION SHEET

Branch	Pry Road - P1	**Date**	9/5/2008
Section	1 1/2" RAP	**Inspector**	SK
Sample Unit		**Area of Sample**	2900 sf

DISTRESS TYPES

1. Improper Cross Section (linear feet)
2. Inadequate Roadside Drainage (linear feet)
3. Corrugations (square feet)
4. Dust
5. Potholes (number)
6. Ruts (square feet)
7. Loose Aggregate (linear feet)

DISTRESS QUANTITY AND SEVERITY

Type		1	2	3	4	5	6	7
Quantity and Severity	L							200'
	M							
	H							

URCI CALCULATION

Distress Type	Density	Severity	Deduct Value
7	6.9%	L	11
		Total Deduct Value =	11
		q =	1
URCI = 90		**Rating =**	EXC.

REMARKS:

- 3 % Cross Slope

- 100' low loose aggregate on west side
- 100' low loose aggregate on east side

1/2" - 1 1/4"

UNSURFACED ROAD INSPECTION SHEET

Branch	Pry Road - P1	**Date**	9/18/2008
Section	1 1/2" RAP	**Inspector**	SK
Sample Unit		**Area of Sample**	2900 sf

DISTRESS TYPES

1. Improper Cross Section (linear feet)
2. Inadequate Roadside Drainage (linear feet)
3. Corrugations (square feet)
4. Dust
5. Potholes (number)
6. Ruts (square feet)
7. Loose Aggregate (linear feet)

DISTRESS QUANTITY AND SEVERITY

Type		1	2	3	4	5	6	7
Quantity and Severity	L							140'
	M							
	H							

URCI CALCULATION

Distress Type	Density	Severity	Deduct Value
7	4.8%	L	9
		Total Deduct Value =	9
		q =	1
URCI = 91		**Rating =**	EXC.

REMARKS:

• 3 % Cross Slope

• 100' low loose aggregate on west side 1/2" - 1 1/4"

• 40' low loose aggregate on east side 1/2" - 3/4 "

UNSURFACED ROAD INSPECTION SHEET

Branch Pry Road - P1 **Date** 10/4/2008
Section 1 1/2" RAP **Inspector** SK
Sample Unit **Area of Sample** 2900 sf

DISTRESS TYPES

1. Improper Cross Section (linear feet)
2. Inadequate Roadside Drainage (linear feet)
3. Corrugations (square feet)
4. Dust
5. Potholes (number)
6. Ruts (square feet)
7. Loose Aggregate (linear feet)

DISTRESS QUANTITY AND SEVERITY

Type		1	2	3	4	5	6	7
Quantity and Severity	L						200 sf	200'
	M							
	H							

URCI CALCULATION

Distress Type	Density	Severity	Deduct Value
6	6.9%	L	10
7	6.9%	L	11
		Total Deduct Value =	21
		q =	2
URCI = 85		Rating =	EXC.

REMARKS:

• 3 % Cross Slope

• 100' low loose aggregate on both sides 1/2" - 1 1/4"

• 100' x 2' low rutting on west side 3/4 " deep

UNSURFACED ROAD INSPECTION SHEET

Branch	Pry Road - P0	**Date**	6/24/2008
Section	100% Gravel	**Inspector**	SK & GH
Sample Unit		**Area of Sample**	25' x 100 ' = 2500 sf

DISTRESS TYPES

1. Improper Cross Section (linear feet)
2. Inadequate Roadside Drainage (linear feet)
3. Corrugations (square feet)
4. Dust
5. Potholes (number)
6. Ruts (square feet)
7. Loose Aggregate (linear feet)

DISTRESS QUANTITY AND SEVERITY

Type		1	2	3	4	5	6	7
Quantity and Severity	L							
	M							
	H							

URCI CALCULATION

Distress Type	Density	Severity	Deduct Value
		Total Deduct Value =	0
		q =	0
URCI = 100		**Rating =**	EXC.

REMARKS:

- 2 % Cross Slope
- No Distresses

UNSURFACED ROAD INSPECTION SHEET

Branch	Pry Road - P0	**Date**	7/11/2008
Section	100% Gravel	**Inspector**	SK
Sample Unit		**Area of Sample**	2500 sf

DISTRESS TYPES

1. Improper Cross Section (linear feet)
2. Inadequate Roadside Drainage (linear feet)
3. Corrugations (square feet)
4. Dust
5. Potholes (number)
6. Ruts (square feet)
7. Loose Aggregate (linear feet)

DISTRESS QUANTITY AND SEVERITY

Type		1	2	3	4	5	6	7
Quantity and Severity	L							
	M							
	H							

URCI CALCULATION

Distress Type	Density	Severity	Deduct Value
		Total Deduct Value =	0
		q =	0
URCI = 100		**Rating =**	EXC.

REMARKS:

- 2 % Cross Slope
- No Distresses

UNSURFACED ROAD INSPECTION SHEET

Branch Pry Road - P0 **Date** 7/28/2008
Section 100% Gravel **Inspector** SK
Sample Unit **Area of Sample** 2500 sf

DISTRESS TYPES

1. Improper Cross Section (linear feet)
2. Inadequate Roadside Drainage (linear feet)
3. Corrugations (square feet)
4. Dust
5. Potholes (number)
6. Ruts (square feet)
7. Loose Aggregate (linear feet)

DISTRESS QUANTITY AND SEVERITY

Type		1	2	3	4	5	6	7
Quantity and Severity	L							
	M							
	H							

URCI CALCULATION

Distress Type	Density	Severity	Deduct Value
		Total Deduct Value =	0
		q =	0
URCI = 100		**Rating =**	EXC.

REMARKS:

- 2 % Cross Slope
- No Distresses

UNSURFACED ROAD INSPECTION SHEET

Branch	Pry Road - P0	**Date**	8/6/2008
Section	100% Gravel	**Inspector**	SK
Sample Unit		**Area of Sample**	2500 sf

DISTRESS TYPES

1. Improper Cross Section (linear feet)
2. Inadequate Roadside Drainage (linear feet)
3. Corrugations (square feet)
4. Dust
5. Potholes (number)
6. Ruts (square feet)
7. Loose Aggregate (linear feet)

DISTRESS QUANTITY AND SEVERITY

Type		1	2	3	4	5	6	7
Quantity and Severity	L							
	M							
	H							

URCI CALCULATION

Distress Type	Density	Severity	Deduct Value
		Total Deduct Value =	0
		q =	0
URCI = 100		**Rating =**	EXC.

REMARKS:

- 2 % Cross Slope
- No Distresses

UNSURFACED ROAD INSPECTION SHEET

Branch	Pry Road - P0	**Date**	8/13/2008
Section	100% Gravel	**Inspector**	SK
Sample Unit		**Area of Sample**	2500 sf

DISTRESS TYPES

1. Improper Cross Section (linear feet)
2. Inadequate Roadside Drainage (linear feet)
3. Corrugations (square feet)
4. Dust
5. Potholes (number)
6. Ruts (square feet)
7. Loose Aggregate (linear feet)

DISTRESS QUANTITY AND SEVERITY

Type		1	2	3	4	5	6	7
Quantity and Severity	L							
	M							
	H							

URCI CALCULATION

Distress Type	Density	Severity	Deduct Value
		Total Deduct Value =	0
		q =	0
URCI = 100		**Rating =**	EXC.

REMARKS:

- 2 % Cross Slope
- No Distresses

UNSURFACED ROAD INSPECTION SHEET

Branch	Pry Road - P0	**Date**	8/22/2008
Section	100% Gravel	**Inspector**	SK
Sample Unit		**Area of Sample**	2500 sf

DISTRESS TYPES

1. Improper Cross Section (linear feet)
2. Inadequate Roadside Drainage (linear feet)
3. Corrugations (square feet)
4. Dust
5. Potholes (number)
6. Ruts (square feet)
7. Loose Aggregate (linear feet)

DISTRESS QUANTITY AND SEVERITY

Type		**1**	**2**	**3**	**4**	**5**	**6**	**7**
Quantity and Severity	**L**							
	M							
	H							

URCI CALCULATION

Distress Type	**Density**	**Severity**	**Deduct Value**
		Total Deduct Value =	0
		q =	0
URCI = 100		**Rating =**	EXC.

REMARKS:

- 2 % Cross Slope
- No Distresses
- Re-bladed 8/21/2008

UNSURFACED ROAD INSPECTION SHEET

Branch	Pry Road - P0	**Date**	9/5/2008
Section	100% Gravel	**Inspector**	SK
Sample Unit		**Area of Sample**	2500 sf

DISTRESS TYPES

1. Improper Cross Section (linear feet)
2. Inadequate Roadside Drainage (linear feet)
3. Corrugations (square feet)
4. Dust
5. Potholes (number)
6. Ruts (square feet)
7. Loose Aggregate (linear feet)

DISTRESS QUANTITY AND SEVERITY

Type		**1**	**2**	**3**	**4**	**5**	**6**	**7**
Quantity and Severity	**L**							
	M							
	H							

URCI CALCULATION

Distress Type	**Density**	**Severity**	**Deduct Value**
		Total Deduct Value =	0
		q =	0
URCI = 100		**Rating =**	EXC.

REMARKS:

- 2 % Cross Slope
- No Distresses

UNSURFACED ROAD INSPECTION SHEET

Branch	Pry Road - P0	**Date**	9/18/2008
Section	100% Gravel	**Inspector**	SK
Sample Unit		**Area of Sample**	2500 sf

DISTRESS TYPES

1. Improper Cross Section (linear feet)
2. Inadequate Roadside Drainage (linear feet)
3. Corrugations (square feet)
4. Dust
5. Potholes (number)
6. Ruts (square feet)
7. Loose Aggregate (linear feet)

DISTRESS QUANTITY AND SEVERITY

Type		**1**	**2**	**3**	**4**	**5**	**6**	**7**
Quantity and Severity	**L**							
	M							
	H							

URCI CALCULATION

Distress Type	**Density**	**Severity**	**Deduct Value**
		Total Deduct Value =	0
		q =	0
URCI = 100		**Rating =**	EXC.

REMARKS:

- 2 % Cross Slope
- No Distresses

UNSURFACED ROAD INSPECTION SHEET

Branch	Pry Road - P0	**Date**	10/4/2008
Section	100% Gravel	**Inspector**	SK
Sample Unit		**Area of Sample**	2500 sf

DISTRESS TYPES

1. Improper Cross Section (linear feet)
2. Inadequate Roadside Drainage (linear feet)
3. Corrugations (square feet)
4. Dust
5. Potholes (number)
6. Ruts (square feet)
7. Loose Aggregate (linear feet)

DISTRESS QUANTITY AND SEVERITY

Type		1	2	3	4	5	6	7
Quantity and Severity	L							
	M							
	H							

URCI CALCULATION

Distress Type	Density	Severity	Deduct Value
		Total Deduct Value =	0
		q =	0
URCI = 100		**Rating =**	EXC.

REMARKS:

- 2 % Cross Slope
- No Distresses

UNSURFACED ROAD INSPECTION SHEET

Branch	Schoonover - S2 (RAP Blend)	**Date**	7/14/2008
Section	RAP Mix no CaCl	**Inspector**	SK
Sample Unit		**Area of Sample**	26' x 100 ' = 2600 sf

DISTRESS TYPES

1. Improper Cross Section (linear feet)
2. Inadequate Roadside Drainage (linear feet)
3. Corrugations (square feet)
4. Dust
5. Potholes (number)
6. Ruts (square feet)
7. Loose Aggregate (linear feet)

DISTRESS QUANTITY AND SEVERITY

Type		1	2	3	4	5	6	7
Quantity and Severity	L							
	M							
	H							

URCI CALCULATION

Distress Type	Density	Severity	Deduct Value
		Total Deduct Value =	0
		q =	0
URCI = 100		**Rating =**	EXC.

REMARKS:

- 2 - 3 % Cross Slope
- No Distresses
- Loose Aggregate may become a distress soon but it is not enough to be one now.

UNSURFACED ROAD INSPECTION SHEET

Branch Schoonover - S2 (RAP Blend) **Date** 7/29/2008
Section RAP Mix no CaCl **Inspector** SK
Sample Unit **Area of Sample** 26' x 100 ' = 2600 sf

DISTRESS TYPES

1. Improper Cross Section (linear feet)
2. Inadequate Roadside Drainage (linear feet)
3. Corrugations (square feet)
4. Dust
5. Potholes (number)
6. Ruts (square feet)
7. Loose Aggregate (linear feet)

DISTRESS QUANTITY AND SEVERITY

Type		1	2	3	4	5	6	7
Quantity and Severity	L							100 '
	M							
	H							

URCI CALCULATION

Distress Type	Density	Severity	Deduct Value
7	3.8%	L	7

Total Deduct Value = 7
q = 1
URCI = 95 **Rating =** EXC.

REMARKS:

- 2 1/2 % Cross Slope
- 100' of Loose Aggregate on North Side (Pic. 971).

1/2" - 1"

UNSURFACED ROAD INSPECTION SHEET

Branch	Schoonover - S2 (RAP Blend)	**Date**	8/6/2008
Section	RAP Mix no CaCl	**Inspector**	SK
Sample Unit		**Area of Sample**	26' x 100 ' = 2600 sf

DISTRESS TYPES

1. Improper Cross Section (linear feet)
2. Inadequate Roadside Drainage (linear feet)
3. Corrugations (square feet)
4. Dust
5. Potholes (number)
6. Ruts (square feet)
7. Loose Aggregate (linear feet)

DISTRESS QUANTITY AND SEVERITY

Type		1	2	3	4	5	6	7
Quantity and Severity	L							100 '
	M							
	H							

URCI CALCULATION

Distress Type	Density	Severity	Deduct Value
7	3.8%	L	7
		Total Deduct Value =	7
		q =	1
URCI = 95		**Rating =**	EXC.

REMARKS:

- 2 % Cross Slope
- 100' of Loose Aggregate on North Side

3/4" - 1"

UNSURFACED ROAD INSPECTION SHEET

Branch	Schoonover - S2 (RAP Blend)	**Date**	8/13/2008
Section	RAP Mix no CaCl	**Inspector**	SK
Sample Unit		**Area of Sample**	26' x 100 ' = 2600 sf

DISTRESS TYPES

1. Improper Cross Section (linear feet)
2. Inadequate Roadside Drainage (linear feet)
3. Corrugations (square feet)
4. Dust
5. Potholes (number)
6. Ruts (square feet)
7. Loose Aggregate (linear feet)

DISTRESS QUANTITY AND SEVERITY

Type		1	2	3	4	5	6	7
Quantity and Severity	L							100 '
	M							
	H							

URCI CALCULATION

Distress Type	Density	Severity	Deduct Value
7	3.8%	L	7
		Total Deduct Value =	7
		q =	1
URCI = 95		**Rating =**	EXC.

REMARKS:

- 2 % Cross Slope
- 100' of Loose Aggregate on North Side

UNSURFACED ROAD INSPECTION SHEET

Branch Schoonover - S2 (RAP Blend)
Section RAP Mix no CaCl
Sample Unit

Date 8/21/2008
Inspector SK
Area of Sample 26' x 100 ' = 2600 sf

DISTRESS TYPES

1. Improper Cross Section (linear feet)
2. Inadequate Roadside Drainage (linear feet)
3. Corrugations (square feet)
4. Dust
5. Potholes (number)
6. Ruts (square feet)
7. Loose Aggregate (linear feet)

DISTRESS QUANTITY AND SEVERITY

Type		1	2	3	4	5	6	7
Quantity and Severity	L							140'
	M							
	H							

URCI CALCULATION

Distress Type	Density	Severity	Deduct Value
7	5.4%	L	9
		Total Deduct Value =	9
		q =	1
URCI = 92		**Rating =**	EXC.

REMARKS:

- 2 % Cross Slope

- 100' of Loose Aggregate on North Side
3/4" - 1 1/4"

- 40 ' of Loose Aggregate on South Side
1/2 " - 1"

UNSURFACED ROAD INSPECTION SHEET

Branch	Schoonover - S2 (RAP Blend)	**Date**	9/1/2008
Section	RAP Mix no CaCl	**Inspector**	SK
Sample Unit		**Area of Sample**	26' x 100 ' = 2600 sf

DISTRESS TYPES

1. Improper Cross Section (linear feet)
2. Inadequate Roadside Drainage (linear feet)
3. Corrugations (square feet)
4. Dust
5. Potholes (number)
6. Ruts (square feet)
7. Loose Aggregate (linear feet)

DISTRESS QUANTITY AND SEVERITY

Type		1	2	3	4	5	6	7
Quantity and Severity	L							160'
	M							
	H							

URCI CALCULATION

Distress Type	Density	Severity	Deduct Value
7	6.2%	L	11
		Total Deduct Value =	11
		q =	1
URCI = 90		**Rating =**	EXC.

REMARKS:

- 2 % Cross Slope
- 100' of Loose Aggregate on North Side 3/4" - 1 1/4"
- 60 ' of Loose Aggregate on South Side 1/2 " - 1"

UNSURFACED ROAD INSPECTION SHEET

Branch Schoonover - S2 (RAP Blend) **Date** 10/4/2008
Section RAP Mix no CaCl **Inspector** SK
Sample Unit **Area of Sample** 26' x 100 ' = 2600 sf

DISTRESS TYPES

1. Improper Cross Section (linear feet)
2. Inadequate Roadside Drainage (linear feet)
3. Corrugations (square feet)
4. Dust
5. Potholes (number)
6. Ruts (square feet)
7. Loose Aggregate (linear feet)

DISTRESS QUANTITY AND SEVERITY

Type		1	2	3	4	5	6	7
Quantity and Severity	L							200'
	M							
	H							

URCI CALCULATION

Distress Type	Density	Severity	Deduct Value
7	7.7%	L	12

Total Deduct Value = 12
q = 1
URCI = 88 **Rating =** EXC.

REMARKS:

- 2 % Cross Slope
- 100' of Loose Aggregate on North Side
3/4" - 1 1/4"
- 100 ' of Loose Aggregate on South Side
1/2 " - 1 1/2"

UNSURFACED ROAD INSPECTION SHEET

Branch	Schoonover - S1 (RAP Blend w/ CaCl)	**Date**	7/14/2008
Section	RAP Mix with CaCl	**Inspector**	SK
Sample Unit		**Area of Sample**	27' x 100 ' = 2700 sf

DISTRESS TYPES

1. Improper Cross Section (linear feet)
2. Inadequate Roadside Drainage (linear feet)
3. Corrugations (square feet)
4. Dust
5. Potholes (number)
6. Ruts (square feet)
7. Loose Aggregate (linear feet)

DISTRESS QUANTITY AND SEVERITY

Type		1	2	3	4	5	6	7
Quantity and Severity	**L**							
	M							
	H							

URCI CALCULATION

Distress Type	**Density**	**Severity**	**Deduct Value**
		Total Deduct Value =	0
		q =	0
URCI = 100		**Rating =**	EXC.

REMARKS:

- 2 % Cross Slope
- No Distresses
- Potential for rutting

UNSURFACED ROAD INSPECTION SHEET

Branch Schoonover - S1 (RAP Blend w/ CaCl)
Section RAP Mix with CaCl
Sample Unit

Date 7/29/2008
Inspector SK
Area of Sample 27' x 100 ' = 2700 sf

DISTRESS TYPES

1. Improper Cross Section (linear feet)
2. Inadequate Roadside Drainage (linear feet)
3. Corrugations (square feet)
4. Dust
5. Potholes (number)
6. Ruts (square feet)
7. Loose Aggregate (linear feet)

DISTRESS QUANTITY AND SEVERITY

Type		1	2	3	4	5	6	7
Quantity and Severity	L							
	M							
	H							

URCI CALCULATION

Distress Type	Density	Severity	Deduct Value
		Total Deduct Value =	0
		q =	0
URCI = 100		Rating =	EXC.

REMARKS:

- 2 % Cross Slope
- No Distresses
- Potential for rutting in future
- Potential Loose Aggregate on South Side in future

UNSURFACED ROAD INSPECTION SHEET

Branch Schoonover - S1 (RAP Blend w/ CaCl) **Date** 8/6/2008
Section RAP Mix with CaCl **Inspector** SK
Sample Unit **Area of Sample** 27' x 100 ' = 2700 sf

DISTRESS TYPES

1. Improper Cross Section (linear feet)
2. Inadequate Roadside Drainage (linear feet)
3. Corrugations (square feet)
4. Dust
5. Potholes (number)
6. Ruts (square feet)
7. Loose Aggregate (linear feet)

DISTRESS QUANTITY AND SEVERITY

Type		1	2	3	4	5	6	7
Quantity and Severity	L						150 sf	30 '
	M							
	H							

URCI CALCULATION

Distress Type	Density	Severity	Deduct Value
7	1.1%	L	2
6	5.5%	L	8
		Total Deduct Value =	10
		q =	1
URCI = 90		**Rating =**	EXC.

REMARKS:

• 2 % Cross Slope

• 50 ' of Low rutting on south side
50' x 3' = 150 sf

• 30' of Loose Aggregate on south side
1/2" - 3/4 "

UNSURFACED ROAD INSPECTION SHEET

Branch Schoonover - S1 (RAP Blend w/ CaCl) **Date** 8/13/2008
Section RAP Mix with CaCl **Inspector** SK
Sample Unit **Area of Sample** 27' x 100 ' = 2700 sf

DISTRESS TYPES

1. Improper Cross Section (linear feet)
2. Inadequate Roadside Drainage (linear feet)
3. Corrugations (square feet)
4. Dust
5. Potholes (number)
6. Ruts (square feet)
7. Loose Aggregate (linear feet)

DISTRESS QUANTITY AND SEVERITY

Type		1	2	3	4	5	6	7
Quantity and Severity	L						150 sf	50'
	M							
	H							

URCI CALCULATION

Distress Type	Density	Severity	Deduct Value
6	5.5%	L	8
7	1.8%	L	4
		Total Deduct Value =	12
		q =	1
URCI = 87		**Rating =**	EXC.

REMARKS:

• 2 % Cross Slope

• 50 ' of Low rutting on south side
50' x 3' = 150 sf

• 50' of Loose Aggregate on south side
1/2" - 3/4 "

UNSURFACED ROAD INSPECTION SHEET

Branch Schoonover - S1 (RAP Blend w/ CaCl)
Section RAP Mix with CaCl
Sample Unit

Date 8/21/2008
Inspector SK
Area of Sample 27' x 100 ' = 2700 sf

DISTRESS TYPES

1. Improper Cross Section (linear feet)
2. Inadequate Roadside Drainage (linear feet)
3. Corrugations (square feet)
4. Dust
5. Potholes (number)
6. Ruts (square feet)
7. Loose Aggregate (linear feet)

DISTRESS QUANTITY AND SEVERITY

Type		1	2	3	4	5	6	7
Quantity and Severity	L						225 sf	100'
	M							
	H							

URCI CALCULATION

Distress Type	Density	Severity	Deduct Value
6	8.3%	L	12
7	3.7%	L	7
		Total Deduct Value =	19
		q =	2
URCI = 87		**Rating =**	EXC.

REMARKS:

• 2 % Cross Slope

• 75 ' of Low rutting on south side
75' x 3' = 225 sf

• 100' of Loose Aggregate on south side
1/2" - 1"

UNSURFACED ROAD INSPECTION SHEET

Branch Schoonover - S1 (RAP Blend w/ CaCl)
Section RAP Mix with CaCl
Sample Unit

Date 9/1/2008
Inspector SK
Area of Sample 27' x 100 ' = 2700 sf

DISTRESS TYPES

1. Improper Cross Section (linear feet)
2. Inadequate Roadside Drainage (linear feet)
3. Corrugations (square feet)
4. Dust
5. Potholes (number)
6. Ruts (square feet)
7. Loose Aggregate (linear feet)

DISTRESS QUANTITY AND SEVERITY

Type		1	2	3	4	5	6	7
Quantity and Severity	L						225 sf	125'
	M							
	H							

URCI CALCULATION

Distress Type	Density	Severity	Deduct Value
6	8.3%	L	12
7	4.6%	L	9

Total Deduct Value = 21
q = 2
URCI = 84 **Rating =** EXC.

REMARKS:

- 2 % Cross Slope

- 75 ' of Low rutting on south side
75' x 3' = 225 sf

- 100' of Loose Aggregate on south side
1/2" - 1"

- 25' of Loose Aggregate on north side
1/2" - 3/4"

UNSURFACED ROAD INSPECTION SHEET

Branch Schoonover - S1 (RAP Blend w/ CaCl) **Date** 10/4/2008
Section RAP Mix with CaCl **Inspector** SK
Sample Unit **Area of Sample** 27' x 100 ' = 2700 sf

DISTRESS TYPES
1. Improper Cross Section (linear feet)
2. Inadequate Roadside Drainage (linear feet)
3. Corrugations (square feet)
4. Dust
5. Potholes (number)
6. Ruts (square feet)
7. Loose Aggregate (linear feet)

DISTRESS QUANTITY AND SEVERITY

Type		1	2	3	4	5	6	7
Quantity and Severity	L						135 sf	140'
	M							
	H							

URCI CALCULATION

Distress Type	Density	Severity	Deduct Value
6	5.0%	L	9
7	5.2%	L	9
		Total Deduct Value =	17
		q =	2
URCI = 88		**Rating =**	EXC.

REMARKS:

- 2 % Cross Slope
- 45 ' of Low rutting on south side
75' x 3' = 135 sf
- 100' of Loose Aggregate on south side
1/2" - 1"
- 40' of Loose Aggregate on north side
1/2" - 3/4"

UNSURFACED ROAD INSPECTION SHEET

Branch	Schoonover - S0 (100% Gravel w/ CaCl)	**Date**	7/14/2008
Section	Gravel with CaCl	**Inspector**	SK
Sample Unit		**Area of Sample**	27' x 100 ' = 2700 sf

DISTRESS TYPES

1. Improper Cross Section (linear feet)
2. Inadequate Roadside Drainage (linear feet)
3. Corrugations (square feet)
4. Dust
5. Potholes (number)
6. Ruts (square feet)
7. Loose Aggregate (linear feet)

DISTRESS QUANTITY AND SEVERITY

Type		1	2	3	4	5	6	7
Quantity and Severity	L							
	M							
	H							

URCI CALCULATION

Distress Type	Density	Severity	Deduct Value
		Total Deduct Value =	0
		q =	0
URCI = 100		**Rating =**	EXC.

REMARKS:

- 2 % Cross Slope
- No Distresses
- Potential for rutting

UNSURFACED ROAD INSPECTION SHEET

Branch Schoonover - S0 (100% Gravel w/ CaCl)
Date 7/29/2008
Section Gravel with CaCl
Inspector SK
Sample Unit
Area of Sample 27' x 100 ' = 2700 sf

DISTRESS TYPES

1. Improper Cross Section (linear feet)
2. Inadequate Roadside Drainage (linear feet)
3. Corrugations (square feet)
4. Dust
5. Potholes (number)
6. Ruts (square feet)
7. Loose Aggregate (linear feet)

DISTRESS QUANTITY AND SEVERITY

Type		1	2	3	4	5	6	7
Quantity and Severity	L						100 sf	
	M							
	H							

URCI CALCULATION

Distress Type	Density	Severity	Deduct Value
6	3.7%	L	4

Total Deduct Value = 4
q = 0
Rating = EXC.

URCI = 97

REMARKS:

- 2 % Cross Slope
- 1' x 100' Rutting. Small but noticeable (Pic. 967, 968)

UNSURFACED ROAD INSPECTION SHEET

Branch Schoonover - S0 (100% Gravel w/ CaCl)
Section Gravel with CaCl
Sample Unit

Date 8/6/2008
Inspector SK
Area of Sample 27' x 100 ' = 2700 sf

DISTRESS TYPES

1. Improper Cross Section (linear feet)
2. Inadequate Roadside Drainage (linear feet)
3. Corrugations (square feet)
4. Dust
5. Potholes (number)
6. Ruts (square feet)
7. Loose Aggregate (linear feet)

DISTRESS QUANTITY AND SEVERITY

Type		1	2	3	4	5	6	7
Quantity and Severity	L						100 sf	120'
	M							
	H							

URCI CALCULATION

Distress Type	Density	Severity	Deduct Value
6	3.7%	L	5
7	4.4%	L	8

Total Deduct Value = 13
q = 2
Rating = EXC.

URCI = 90

REMARKS:

- 2 % Cross Slope
- 1' x 100' Rutting down centerline
1 " deep
- 100' of Loose Aggregate on south side
3/4" - 1 1/2 "
- 20' of Loose Aggregate on north side
1/2" - 1"

UNSURFACED ROAD INSPECTION SHEET

Branch	Schoonover - S0 (100% Gravel w/ CaCl)	**Date**	8/13/2008
Section	Gravel with CaCl	**Inspector**	SK
Sample Unit		**Area of Sample**	27' x 100 ' = 2700 sf

DISTRESS TYPES

1. Improper Cross Section (linear feet)
2. Inadequate Roadside Drainage (linear feet)
3. Corrugations (square feet)
4. Dust
5. Potholes (number)
6. Ruts (square feet)
7. Loose Aggregate (linear feet)

DISTRESS QUANTITY AND SEVERITY

Type		1	2	3	4	5	6	7
Quantity and Severity	L							
	M							
	H							

URCI CALCULATION

Distress Type	Density	Severity	Deduct Value

Total Deduct Value =

q =

URCI = **Rating =**

REMARKS:

- no inspection recorded

UNSURFACED ROAD INSPECTION SHEET

Branch Schoonover - S0 (100% Gravel w/ CaCl) **Date** 8/21/2008
Section Gravel with CaCl **Inspector** SK
Sample Unit **Area of Sample** 27' x 100 ' = 2700 sf

DISTRESS TYPES

1. Improper Cross Section (linear feet)
2. Inadequate Roadside Drainage (linear feet)
3. Corrugations (square feet)
4. Dust
5. Potholes (number)
6. Ruts (square feet)
7. Loose Aggregate (linear feet)

DISTRESS QUANTITY AND SEVERITY

Type		1	2	3	4	5	6	7
Quantity and Severity	L						200 sf	150'
	M							
	H							

URCI CALCULATION

Distress Type	Density	Severity	Deduct Value
6	7.4%	L	10
7	5.6%	L	10
		Total Deduct Value =	20
		q =	2
URCI = 85		**Rating =**	EXC.

REMARKS:

• 2 % Cross Slope

• 2' x 100' Low Rutting down centerline
1 " deep

• 50' of Loose Aggregate on south side
1/2" - 3/4"

• 100' of Loose Aggregate on north side
1/2" - 1"

UNSURFACED ROAD INSPECTION SHEET

Branch	Schoonover - S0 (100% Gravel w/ CaCl)	**Date**	9/1/2008
Section	Gravel with CaCl	**Inspector**	SK
Sample Unit		**Area of Sample**	27' x 100 ' = 2700 sf

DISTRESS TYPES

1. Improper Cross Section (linear feet)
2. Inadequate Roadside Drainage (linear feet)
3. Corrugations (square feet)
4. Dust
5. Potholes (number)
6. Ruts (square feet)
7. Loose Aggregate (linear feet)

DISTRESS QUANTITY AND SEVERITY

Type		1	2	3	4	5	6	7
Quantity and Severity	L						200 sf	200'
	M							
	H							

URCI CALCULATION

Distress Type	Density	Severity	Deduct Value
6	7.4%	L	10
7	7.4%	L	12
		Total Deduct Value =	22
		q =	2
URCI = 83		**Rating =**	Very good

REMARKS:

• 2 % Cross Slope

• 2' x 100' Low Rutting down centerline
1 " deep

• 100' of Loose Aggregate on Both sides
1/2" - 1"

UNSURFACED ROAD INSPECTION SHEET

Branch Schoonover - S0 (100% Gravel w/ CaCl) **Date** 10/4/2008
Section Gravel with CaCl **Inspector** SK
Sample Unit **Area of Sample** 27' x 100 ' = 2700 sf

DISTRESS TYPES

1. Improper Cross Section (linear feet)
2. Inadequate Roadside Drainage (linear feet)
3. Corrugations (square feet)
4. Dust
5. Potholes (number)
6. Ruts (square feet)
7. Loose Aggregate (linear feet)

DISTRESS QUANTITY AND SEVERITY

Type		1	2	3	4	5	6	7
Quantity and Severity	L			1400 sf			300 sf	200'
	M						200 sf	
	H							

URCI CALCULATION

Distress Type	Density	Severity	Deduct Value
3	51.9%	L	24
6	11.1%	L	15
6	7.4	M	14
7	7.4	L	12
		Total Deduct Value =	65
		q =	4
URCI = 65		**Rating =**	good

REMARKS:

- 2 % Cross Slope
- 2' x 100' Medium Rutting down centerline 1 1/2 " deep
- 100' of Loose Aggregate on Both sides 1/2" - 1"
- 100' x 3' low rutting on south side 1/2" - 1" deep
- < 1" corrugations centered on centerline 100' x 14'

APPENDIX C

MATERIAL TESTING DATA SHEETS

WYOMING DEPARTMENT OF TRANSPORTATION
Materials Testing Laboratory
SAMPLE TRANSMITTAL

Form T-120
REVISED 8/99

☐ Metric
☒ English

☐ Preliminary
☐ Construction

☐ QC/QA

Lab # ______

Date Sampled 4-30-08
Date Received ______
Project Number UW RESEARCH
Road Section ATLAS ROAD
Resident Engineer HUNTINGTON
at : UW
Pit or Source ATLAS
County LARAMIE

Sample Distribution

☐ Soils ☑ Aggregate ☐ Concrete ☐ Chemistry ☐ Geology

Sample Number(s) UW-A1-CONTG S # ______ TH # ______

Multiple Samples 1 of 1

Location (Belt, Stockpile, etc.) SURFACE at: (Sta., kp., M.P., etc.) ______

Vertical Limits ______ to : ______

Horizontal Limits ______ to : ______

Quantity Represented ______

For Use As :

☐ Profile	☐ BSE	☐ PMP Type ______ Grd. ______	☐ Conc. Coarse Aggregate
☐ Borrow	☐ CB, Grd. ______	☐ RPMP ______	☐ Conc. Med. Aggregate
☐ Topping	☐ PMB	☐ PMWC, Type ______	☐ Conc. Fine Aggregate
☐ Alkali	☐ CTB	☐ CCA, Type ______	☐ Conc. Cylinders
☐ Check Curve	☐ Filler	☐ Maint. Type ______	☐ Conc. Beams
☐ Final Emb.	☐ Drain Gravel	☐ Check Design	☐ Port. Cement, Type ______
☒ Other SURFACING			Type ______

Geosynthetics (Geogrid/Geotextile)

Product Name ______ Manufacturer ______

Remarks: WASH GRADATION; PL; LL; COHESION VALUE; R-VALUE
FRACTURED FACES; HYDROMETER (GEOLOGY)

Submitted By [signature]

g:\materials\shared\forms\soil & surf-120.xls

Reorder # FR-6042

WYOMING DEPARTMENT OF TRANSPORTATION
MATERIALS LABORATORY
REPORT OF TEST ON SURFACING MATERIALS

Form T-103B
Rev. 9-06
☐ English
☐ Metric

LABORATORY NO. 2008 - 0258 DATE REC'D 4-28-08
SUBMITTED BY G. Huntington AT U.W.
I.D. MARKS DATE SCREENED
SOURCE DATE SAMPLED
QUANTITY REPRESENTED LOCATION
FOR USE AS U.W Research PROJECT CO.

TEST RESULTS

SIEVE SIZE PASSING	RET. WT. LBS.	RET. WT. GRAMS	RET %	PASSING %	RET. WT. LBS.	RET. WT. GRAMS	RET. %	PASSING %	RET. WT. LBS.	RET. WT. GRAMS	RET %	PASSING %
___ MAX		334.4 248.9										"R" Value
3" (75 mm)												
2" (50 mm)												
1 1/2 (3.75 mm)												
1" (25 mm)				100.0								
3/4" (19 mm)	0.4		0.4	99.6								
1/2" (12.5 mm)	1.8		1.7	97.9								26
3/8" (9.50 mm)	2.5		2.4	95.5								54
#4 (4.75 mm)	17.9		17.1	78.[illegible]								260
#8 (2.36 mm)	82.1 / 81.3	62.7	14.6	63.8								1200
#16 (1.18 mm)		46.3	10.8	53.0								
#30 (600 um)		40.8	9.6	43.4								
#50 (300 um)		40.4	9.5	33.9								
#100 (150 um)		23.3	5.5	28.4								
#200 (75 um)		26.4	6.2	22.2								
PAN	8.8	94.3 / 94.5										
	104.7											(4)
LIQUID LIMIT	27											
PLASTICITY INDEX	12											
SAND EQUIVALENT												

Tests	Tech	Date
Screen	CS JJ	5-14
LL - PI	GE	5-14
Wash	MAS	5-14
Gradation	MAS	5-19
Crush		
Crush Wash		
CR LL PI		
LAR		
SE		

REMARKS UW - A1 - CONT (G, H, I) Comb.
Wash Grad ✓
PI: LL: ✓
CV = 392 PSI
"R" Value = 19
Fracture Faces = Insufficient Mat. to Perform test
HyDrometer = See worksheet inside

WYOMING DEPARTMENT OF TRANSPORTATION REV. 5/96
MATERIALS TESTING LABORATORY h:\forms\soil&sur\T-DAVEG.XLS

REPORT OF NATURAL CEMENTATION OF AGGREGATE FINES

REPORT NO. ______ DATE ______
PROJECT NUMBER UW-IA1-Cont (PoH I) comb. SOURCE ______
ENGINEER ______ FOR USE AS ______

TEST RESULTS

F + H²0 = ______
F + M + H²0 = ______
MATERIAL + TARE = ______
O.D. = ______

TARE PAN [g.]

$\frac{\text{O.D.}}{\text{F + H²0 + 500 - F,M,H²0}}$ BULK

$\frac{\text{O.D}}{\text{F + H²0 + O.D. - F,M,H²0}}$ APPARENT

	FLASK	F + M	F + H²0
1	183.3	683.3	683.0
2	170.2	670.2	668.4
3	184.8	684.8	682.6

Moisture @ S.S.E.
MOISTURE SAMPLE FROM -4 S/G

TARE WEIGHT			
WET WEIGHT		WT. OF MOISTURE	
- DRY WEIGHT		÷ DRY WEIGHT	
= WT. OF MOISTURE		MOISTURE % @ S.S.D.	

MOISTURE @ S.S.D + 5% FOR COMPACTION

MOISTURE @ COMPACTION
MOISTURE SAMPLE FROM EXCESS MATERIAL AFTER COMPACTION

TARE WEIGHT			
WET WEIGHT	560	WT. OF MOISTURE	52
- DRY WEIGHT	508	÷ DRY WEIGHT	508
= WT. OF MOISTURE	52	MOIST. % @ COMPACTION	[illegible]

	MACHINE LOAD				PSI
1	1585	÷	4	=	396.3
2	1320	÷	4	=	330.0
3	1800	÷	4	=	450.0
AVG.	1568.3			AVG.	392.1

MOLD
OILED [✓]
UNOILED [ ]

APPARENT S/G	2.577	BULK S/G	2.305
MOISTURE @ S.S.D		ABSORBTION %	4.581
MOISTURE @ COMPACTION	10.2		

NOTES:30ml=2% moisture

______ TESTED BY ______ ENGINEER

GRAIN SIZE DISTRIBUTION TEST DATA

Project: U.W. Research
Project Number: **Client:** G. Huntington

Sample Data

Source: UW-A1-CONT-(G,H,I)
Sample No.: 80289
Elev. or Depth: **Sample Length(in./cm.):**
Location:
Description: Clayey sand

Mechanical Analysis Data

	Initial
Dry sample and tare=	1084.28
Tare =	0.00
Dry sample weight =	1084.28

Sample split on number 10 **sieve**
Split sample data:
Sample and tare = 54.54 **Tare =** .00 **Sample weight =** 54.54
Cumulative weight retained tare= .00
Tare for cumulative weight retained= .00

Sieve	Cumul. Wt. retained	Percent finer
3 inch	0.00	100.0
1.5 inch	0.00	100.0
.75 inch	0.00	100.0
.375 inch	0.00	100.0
# 4	3.83	99.6
# 10	137.85	87.3
# 20	6.54	76.8
# 40	14.64	63.9
# 100	23.71	49.3
# 200	29.07	40.8

Hydrometer Analysis Data

Separation sieve is #10
Percent -#10 based upon complete sample= 87.3
Weight of hydrometer sample: 55.64
Hygroscopic moisture correction:
Moist weight & tare = 168.32
Dry weight & tare = 167.12
Tare = 107.76
Hygroscopic moisture= 2.0 %
Calculated biased weight= 62.47
Automatic temperature correction
Composite correction at 20 deg C = -6.7

Meniscus correction only= 0
Specific gravity of solids= 2.672
Specific gravity correction factor= 0.995
Hydrometer type: 152H
Effective depth L= 16.294964 - 0.164 x Rm

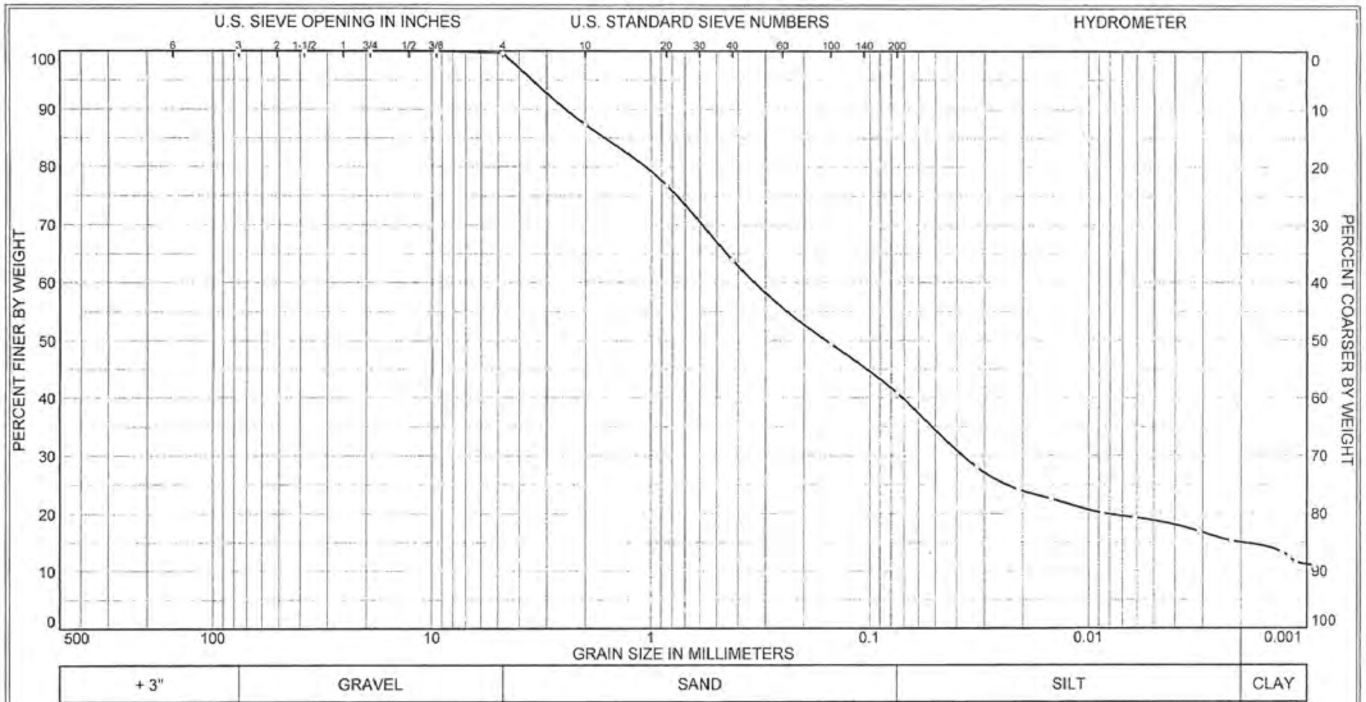
WYDOT GEOLOGY

Elapsed time, min	Temp, deg C	Actual reading	Corrected reading	K	Rm	Eff. depth	Diameter mm	Percent finer
2.00	23.5	23.5	17.6	0.0130	23.5	12.4	0.0324	28.0
5.00	23.5	21.0	15.1	0.0130	21.0	12.9	0.0208	24.1
10.00	23.5	20.0	14.1	0.0130	20.0	13.0	0.0148	22.5
30.00	23.5	18.5	12.6	0.0130	18.5	13.3	0.0086	20.1
60.00	23.5	18.0	12.1	0.0130	18.0	13.3	0.0061	19.3
240.00	23.5	16.5	10.6	0.0130	16.5	13.6	0.0031	16.9
480.00	23.5	15.5	9.6	0.0130	15.5	13.8	0.0022	15.3
1440.00	22.5	14.5	8.3	0.0131	14.5	13.9	0.0013	13.3
1680.00	22.5	14.0	7.8	0.0131	14.0	14.0	0.0012	12.5
1945.00	22.0	13.5	7.2	0.0132	13.5	14.1	0.0011	11.5
2880.00	22.5	13.0	6.8	0.0131	13.0	14.2	0.0009	10.9

Fractional Components

Gravel/Sand based on #4
Sand/Fines based on #200
% **+ 3" =** 0.0 % **GRAVEL =** 0.4 % **SAND =** 58.8
% **SILT =** 25.8 % **CLAY =** 15.0 (% **CLAY COLLOIDS =** 11.1)

D_{85}= 1.64 D_{60}= 0.34 D_{50}= 0.16
D_{30}= 0.04 D_{15}= 0.00



LOCATION	SOURCE	SAMPLE #	DEPTH/ELEV.	MATERIAL DESCRIPTION
	UW-A1-CONT-(G,H,I)	80289		Clayey sand

Project No.	**Client** G. Huntington	**Report Date**	**WYDOT GEOLOGY**
Particle Size Distribution Report			**Cheyenne, WY**
U.W. Research			

Form T-115
Rev. 5/91

WYOMING DEPARTMENT OF TRANSPORTATION

UW RESEARCH
ATLAS ROAD

SOILS STABILOMETER WORK SHEET

TEST SPECIMEN	A	B	C	D
MOLD NO	26	37	4[illegible]	
COMPACTOR AIR PRES.-PSI	250	150	100	
INITIAL MOIST.-%	—	—	—	
WATER ADDED-ML	100	120	140	
WATER ADDED-%	—	—	—	
MOIST AT COMPACTION %	[illegible]	[illegible]	18.7	
WET WEIGHT OF PAT-GMS	1141	1072	1146	
HEIGHT OF PAT-INCHES	2.47	2.40	2.60	
DENSITY-LB. PER CU. FT.	129.3	123.1	119.6	
STAB. Ph AT 1000 LBS	17	34	51	
2000 LBS.	71	111	140	
DISPLACEMENT	3.49	[illegible]	[illegible]	
"R" VALUE	47	33	8/9	
EXUDATION PRESS. PSI	650	350	200	

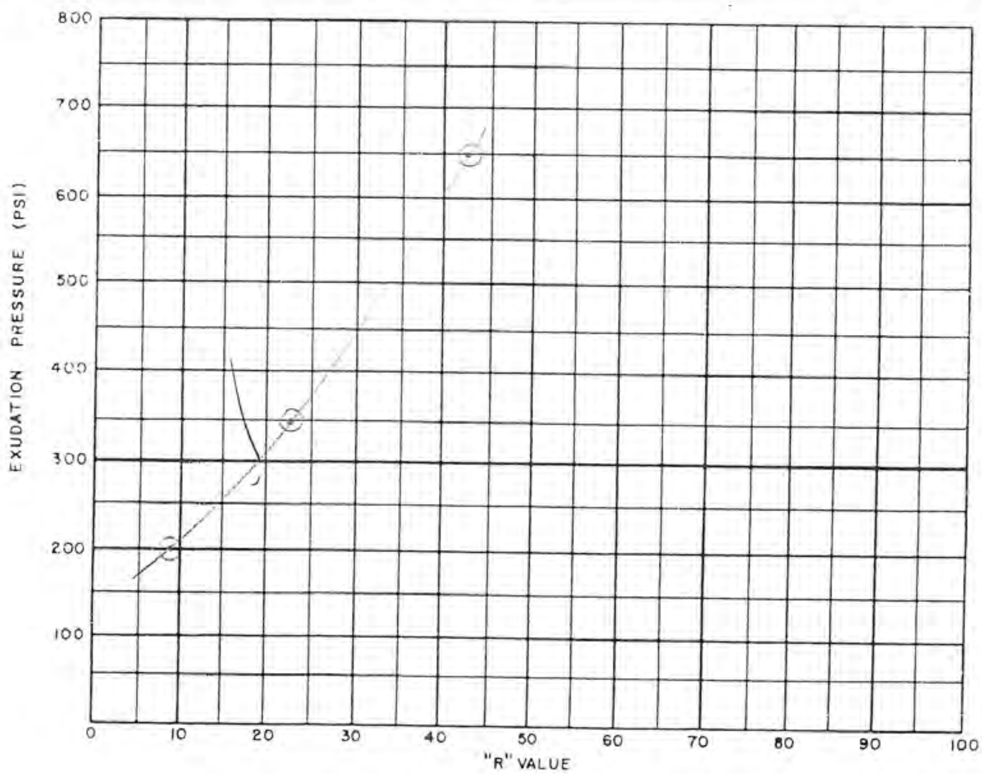
LL	PL	PI	LAB. NO
			08-258

SOIL CLASS & GROUP INDEX	PROJECT

FIELD IDENT.				STATION
INITIAL MOISTURE				1"
WET		DRY		3/4"
DRY		TARE		3/8"
WT. WATER		WT. DRY		NO. 4

EXPANSION SPECIMEN	A	B	C	D
DIAL READING	11	[illegible]	19	
COVER REQUIRED-INCHES				

TIN NO.	REMARKS:	T-115A
	A1 - CONT (G, H, I) comb.	"R" VALUE 19



WYOMING DEPARTMENT OF TRANSPORTATION

Materials Testing Laboratory

SAMPLE TRANSMITTAL

Form T-120
REVISED 8/99

☐ Metric
☒ English

☐ Preliminary
☒ Construction

☐ QC/QA

Lab # 08-21

Date Sampled 4.28.08 Date Received 5-19-08

Project Number UW-Research Road Section Atlas Road

Resident Engineer Huntington at: UW

Pit or Source Atlas Stockpile County Laramie

Sample Distribution

☐ Soils ☒ Aggregate ☐ Concrete ☐ Chemistry ☐ Geology

Multiple Samples ___ of ___

Sample Number(s) UW-Al-RAPO S # ___ TH # ___

Location (Belt, Stockpile, etc.) Windrow at: (Sta., kp., M.P., etc.) ___

Vertical Limits ___ to: ___

Horizontal Limits ___ to: ___

Quantity Represented ___

For Use As :

☐ Profile	☐ BSE	☐ PMP, Type ___ Grd. ___	☐ Conc. Coarse Aggregate
☐ Borrow	☐ CB, Grd. ___	☐ RPMP ___	☐ Conc. Med. Aggregate
☐ Topping	☐ PMB	☐ PMWC, Type ___	☐ Conc. Fine Aggregate
☐ Alkali	☐ CTB	☐ CCA, Type ___	☐ Conc. Cylinders
☐ Check Curve	☐ Filler	☐ Maint. Type ___	☐ Conc. Beams
☐ Final Emb.	☐ Drain Gravel	☐ Check Design	☐ Port. Cement, Type ___
☒ Other Surfacing			Type ___

Geosynthetics (Geogrid/Geotextile)

Product Name ___ Manufacturer ___

Remarks: Asphalt Content by chemical extraction; screened gradation; cohesion value; R-value

2503.6

1068.6

2423.4

Submitted By George Huntington

g:\materials\shared\forms\soil & surf\t120.xls Reorder # FR-6042

WYOMING DEPARTMENT OF TRANSPORTATION
MATERIALS LABORATORY
REPORT OF TEST ON SURFACING MATERIALS

Form T-103B
Rev. 9-06
☐ English
☐ Metric

LABORATORY NO. 2008 - 0258 DATE REC'D 4-28-08
SUBMITTED BY G. Huntington AT U. W.
I.D. MARKS DATE SCREENED
SOURCE DATE SAMPLED
QUANTITY REPRESENTED LOCATION
FOR USE AS U. W Research PROJECT CO.

TEST RESULTS

SIEVE SIZE PASSING	RET. WT. LBS.	RET. WT. GRAMS	RET %	PASSING %	RET. WT. LBS.	RET. WT. GRAMS	RET. %	PASSING %	RET. WT. LBS.	RET. WT. GRAMS	RET %	PASSING %
___ MAX		371.7										'R' Value
3" (75 mm)												
2" (50 mm)				100.0								
1 1/2 (3.75 mm)	0.6		0.5	99.5								
1" (25 mm)	2.5		2.1	97.4								
3/4" (19 mm)	3.4		2.9	94.5								
1/2" (12.5 mm)	14.5		12.2	82.3								212
3/8" (9.50 mm)	9.4		7.9	74.4								306
#4 (4.75 mm)	31.3		26.4	48.0								624
#8 (2.36 mm)	56.7 / 57.6	114.2	14.7	33.3								1200
#16 (1.18 mm)		88.3	11.4	21.9								
#30 (600 um)		66.7	8.6	13.3								
#50 (300 um)		50.1	6.5	6.8								
#100 (150 um)		31.0	4.0	2.8								
#200 (75 um)		14.4	1.9	0.9								
PAN	6.5	7.0										
	118.8											(4)
LIQUID LIMIT	— Asphalt in Sample											
PLASTICITY INDEX	— " " "											
SAND EQUIVALENT	—											

Tests	Tech	Date
Screen	CS JJ	5-19
LL - PI		
Wash		
Gradation	MAS	5-20
Crush		
Crush Wash		
CR LL PI		
LAR		
SE		

REMARKS UW-A1-RAP (D. F. F.)

EXT. CHEM. : See work sheet inside.
GRAD. See work sheet inside.
CV = Not Performed (Asphalt in Sample)
"R" VALUE = 77

FORM T-215
REV. 4/95

WYOMING DEPARTMENT OF TRANSPORTATION
MATERIALS LABORATORY
EXTRACTION WORKSHEET

LABORATORY NO:	08-00021	DATE TESTED:	5/21/2008
ENGINEER:	HUNTINGTON	LOCATION:	LARAMIE
DATE RECEIVED:	5/19/2008	SOURCE:	ATLAS STOCKPILE
SAMPLED ID:	UW-AL-RAPD	PROJECT NO:	UW RESEARCH
FOR USE:	RAP	SOILS & SURFACING LAB NO:	

(1) WT. OF OILED SAMPLE, PAN AND FILTER:	2503.6	(4) WT. OF UNOILED SAMPLE, PAN, AND FILTER:	2423.4
(2) TARE OF PAN AND FILTER:	1068.6	(5) TARE OF PAN AND FILTER:	1068.6
(3) WT. OF OILED SAMPLE: (1 - 2)	1435.0	(6) WT. OF UNOILED SAMPLE: (4 - 5) (1352.3)	1354.8
(7) WT. OF OIL (3 - 6)	80.2	(8) % OIL: (7 / 3)*100	5.59
		THEO. OIL CONTENT:	
		WT. DRY AGG. AFTER WASH:	1265.8

NOTE: WHEN DOING A VACUUM EXTRACTION, ADD 50 GRAMS FOR FILTER AID.

	WT. RET.	% RET.	% PASSING		SPEC'S
37.5mm(1 1/2")					
25mm (1")					
19mm (3/4")			100.0		
12.6mm (1/2")	111.6	8.3	91.7		
9.5mm (3/8")	99.1	7.3	84.4		
4.75mm (#4)	326.4	24.1	60.3		
2.36mm (#8)	212.0	15.7	44.6		
1.18mm (#16)	144.9	10.7	33.9		
600μm (#30)	107.7	8.0	25.9		
300μm (#50)	98.7	7.3	18.6		
150μm (#100)	82.5	6.1	12.5		
75μm (#200)	57.2	4.2	8.3		
PAN	113.4				
25.4					
TOTAL					
	114.7	0.10			

ABSON EXTRACTION

KINEMATIC VISCOSITY:

ABSOLUTE VISCOSITY:

PENETRATION:

CHEMICAL: METHODB OVEN:

CALCULATIONS

RERUN:

REMARKS:

TESTED BY: KMM

Form T-115
Rev. 5/91

UW RESEARCH
ATLAS ROAD

WYOMING DEPARTMENT OF TRANSPORTATION

SOILS STABILOMETER WORK SHEET

TEST SPECIMEN	A	B	C	D
MOLD NO.	37	54	55	
COMPACTOR AIR PRES.-PSI	300	350	350	
INITIAL MOIST. – %	—	—	—	
WATER ADDED – ML	100	90	50	
WATER ADDED – %	—	—	—	
MOIST AT COMPACTION %	8.3	6.7	4.2	
WET WEIGHT OF PAT – GMS	1083	1095	1042	
HEIGHT OF PAT – INCHES	2.43	2.55	2.45	
DENSITY – LB. PER CU. F T.	124.7	121.9	124.4	
STAB. Ph AT 1000 LBS	10	8	6	
2000 LBS.	24	22	18	
DISPLACEMENT	4.78	4.22	4.63	
"R" VALUE	75	79	81	
EXUDATION PRESS. PSI	250	350	650	

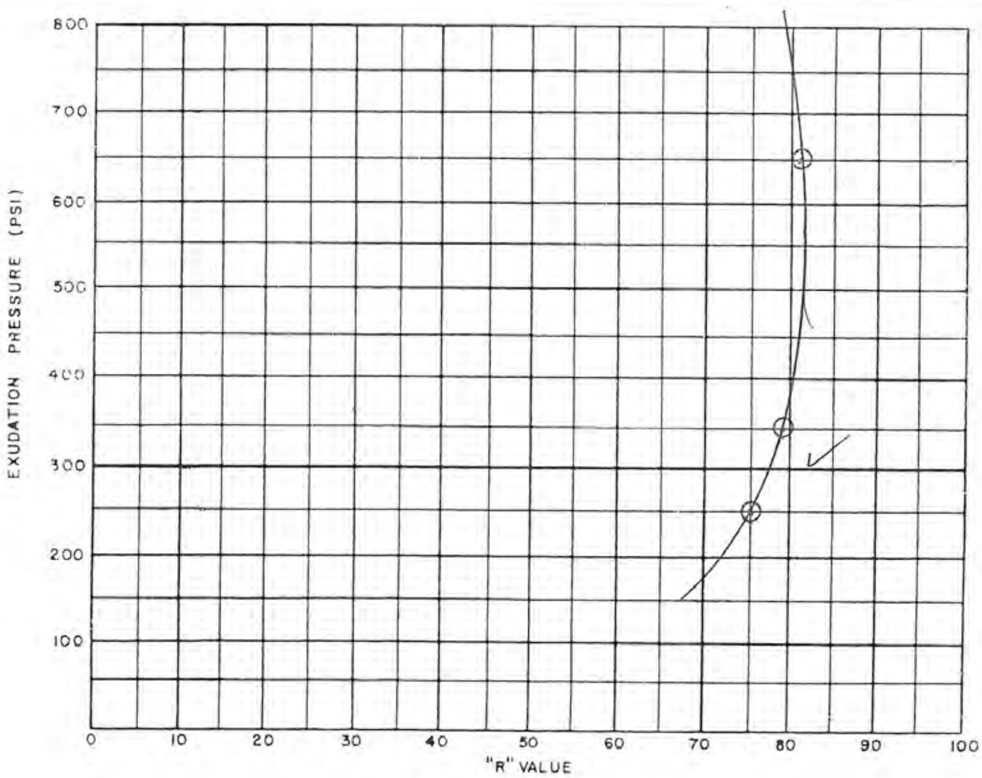
LL	PL	PI	LAB. NO
			08-258

SOIL CLASS & GROUP INDEX	PROJECT

FIELD IDENT				STATION
INITIAL MOISTURE				1"
WET		DRY		3/4"
DRY		TARE		3/8"
WT. WATER		WT. DRY		NO. 4

EXPANSION SPECIMEN	A	B	C	D
DIAL READING				
COVER REQUIRED – INCHES				

TIN NO.	REMARKS:	T-115A
	A1 - RAP (D, E, F)	"R" VALUE 77



WYOMING DEPARTMENT OF TRANSPORTATION

Form T-120
REVISED 8/99

Materials Testing Laboratory

SAMPLE TRANSMITTAL

☐ Metric ☒ English ☐ Preliminary ☒ Construction ☐ QC/QA

Lab # 08-24

Date Sampled 4.28.08 Date Received 5-19-08

Project Number UW Research Road Section Atlas Road

Resident Engineer Huntington at : UW

Pit or Source Atlas Road County Laramie

Sample Distribution

☐ Soils ☒ Aggregate ☐ Concrete ☐ Chemistry ☐ Geology

Sample Number(s) UW-A1-RSD S # ____ TH # ____

Multiple Samples ____ of ____

Location (Belt, Stockpile, etc.) Road Surface at: (Sta., kp., M.P., etc.) ____

Vertical Limits ____ to : ____

Horizontal Limits ____ to : ____

Quantity Represented ____

For Use As :

☐ Profile ☐ BSE ☐ PMP, Type ____ Grd. ____ ☐ Conc. Coarse Aggregate

☐ Borrow ☐ CB, Grd. ____ ☐ RPMP ____ ☐ Conc. Med. Aggregate

☐ Topping ☐ PMB ☐ PMWC, Type ____ ☐ Conc. Fine Aggregate

☐ Alkali ☐ CTB ☐ CCA, Type ____ ☐ Conc. Cylinders

☐ Check Curve ☐ Filler ☐ Maint. Type ____ ☐ Conc. Beams

☐ Final Emb. ☐ Drain Gravel ☐ Check Design ☐ Port. Cement, Type ____

☒ Other Surfacing Type ____

Geosynthetics (Geogrid/Geotextile)

Product Name ____ Manufacturer ____

Remarks: ~~Wash gradation;~~ Asphalt content by chemical extraction; screened gradation; cohesion value; R-Value

2683.4

1069.8

2609.0

Submitted By George Huntington

g:\materials\shared\forms\soil & surf-120.xls Reorder # FR-6042

WYOMING DEPARTMENT OF TRANSPORTATION
MATERIALS LABORATORY
REPORT OF TEST ON SURFACING MATERIALS

Form T-103B
Rev. 9-06
☐ English
☐ Metric

LABORATORY NO. 2008 - 0258 DATE REC'D 4-28-08
SUBMITTED BY G. Huntington AT U. W.
I.D. MARKS DATE SCREENED
SOURCE DATE SAMPLED
QUANTITY REPRESENTED LOCATION
FOR USE AS U.W Research PROJECT CO.

TEST RESULTS

SIEVE SIZE PASSING	RET. WT. LBS.	RET. WT. GRAMS	RET %	PASSING %	RET. WT. LBS.	RET. WT. GRAMS	RET. %	PASSING %	RET. WT. LBS.	RET. WT. GRAMS	RET %	PASSING %
MAX		380.1										"R" Value
3" (75 mm)				100.00								
2" (50 mm)	0.6		0.5	99.5								
1 1/2 (3.75 mm)	0.0		0	99.5								
1" (25 mm)	0.8		0.7	98.8								
3/4" (19 mm)	1.2		1.1	97.7								
1/2" (12.5 mm)	10.7		9.4	88.3								
3/8" (9.50 mm)	7.5		6.6	81.7								140
#4 (4.75 mm)	28.8		25.4	56.3								220
#8 (2.36 mm)	~~63.4~~ 63.7	93.6	13.8	42.5								524
#16 (1.18 mm)		74.1	11.0	31.5								1200
#30 (600 um)		65.4	9.7	21.8								
#50 (300 um)		58.4	8.7	13.1								
#100 (150 um)		41.2	6.1	7.0								
#200 (75 um)		28.0	4.1	2.9								
PAN	19.0	~~19.4~~										
	173.3											(4)
LIQUID LIMIT	— Asphalt in Sample											
PLASTICITY INDEX	—	"	"	"								
SAND EQUIVALENT	—											

Tests	Tech	Date
Screen	CSJJ	5-19
LL - PI		
Wash		
Gradation	MAS	5-20
Crush		
Crush Wash		
CR LL PI		
LAR		
SE		

REMARKS UW-A1-RS (D, E, F)

EXT. CHEM.: See work sheet inside.
GRAD.: See work sheet inside
CV: Not Performed (Asphalt in Sample)
"R" VALUE = 73
Inplace Moisture = 3.8% (D)
1.5% (E)
2.8% (F)

FORM T-215
REV. 4/95

WYOMING DEPARTMENT OF TRANSPORTATION
MATERIALS LABORATORY
EXTRACTION WORKSHEET

LABORATORY NO:	08-00024	DATE TESTED:	5/21/2008
ENGINEER:	HUNTINGTON	LOCATION:	LARAMIE
DATE RECEIVED:	5/19/2008	SOURCE:	ATLAS STOCKPILE
SAMPLED ID:	UW-AL-RSD	PROJECT NO:	UW RESEARCH
FOR USE:	RAP	SOILS & SURFACING LAB NO:	

(1) WT. OF OILED SAMPLE, PAN AND FILTER:	2683.4	(4) WT. OF UNOILED SAMPLE, PAN, AND FILTER:	2609
(2) TARE OF PAN AND FILTER:	1069.8	(5) TARE OF PAN AND FILTER:	1069.8
(3) WT. OF OILED SAMPLE: (1 - 2)	1613.6	(6) WT. OF UNOILED SAMPLE: (4 - 5) (1537.0)	1539.2
(7) WT. OF OIL (3 - 6)	74.4	(8) % OIL: (7 / 3)*100	4.61
		THEO. OIL CONTENT:	
		WT. DRY AGG. AFTER WASH:	1412.5

NOTE: WHEN DOING A VACUUM EXTRACTION, ADD 50 GRAMS FOR FILTER AID.

	WT. RET.	% RET.	% PASSING		SPEC'S
37.5mm(1 1/2")					
25mm (1")			100.0		
19mm (3/4")	5.9	0.3	99.7		
12.6mm (1/2")	106.4	6.9	92.8		
9.5mm (3/8")	85.8	5.8	87.0		
4.75mm (#4)	332.0	21.6	65.4		
2.36mm (#8)	216.6	14.1	51.3		
1.18mm (#16)	166.4	10.8	40.5		
600µm (#30)	134.9	8.8	31.7		
300µm (#50)	129.9	8.4	23.3		
150µm (#100)	110.2	7.2	16.1		
75µm (#200)	87.4	5.7	10.4		
PAN	159.6				
32.9					
TOTAL					
	160.7	0.07			

ABSON EXTRACTION

KINEMATIC VISCOSITY:

ABSOLUTE VISCOSITY:

PENETRATION:

CHEMICAL: METHODB OVEN:

CALCULATIONS

RERUN:

REMARKS:

TESTED BY: KMM

Form T-115
Rev. 5/91

UW RESEARCH
ATLAS ROAD

WYOMING DEPARTMENT OF TRANSPORTATION

SOILS STABILOMETER WORK SHEET

TEST SPECIMEN	A	B	C	D
MOLD NO.	14A	7A	11A	
COMPACTOR AIR PRES.-PSI	350	350	350	
INITIAL MOIST.—%	—	—	—	
WATER ADDED—ML	80	60	70	
WATER ADDED—%	—	—	—	
MOIST AT COMPACTION %	6.7	4.9	5.8	
WET WEIGHT OF PAT—GMS	1144	1093	1153	
HEIGHT OF PAT—INCHES	2.47	2.55	[illegible]	
DENSITY—LB. PER CU. FT.	131.5	124.4	134.8	
STAB. Ph AT 1000 LBS	18	6	10	
2000 LBS.	31	16	23	
DISPLACEMENT	4.27	4.44	4.71	
"R" VALUE	71	84	76	
EXUDATION PRESS. PSI	150	700	430	

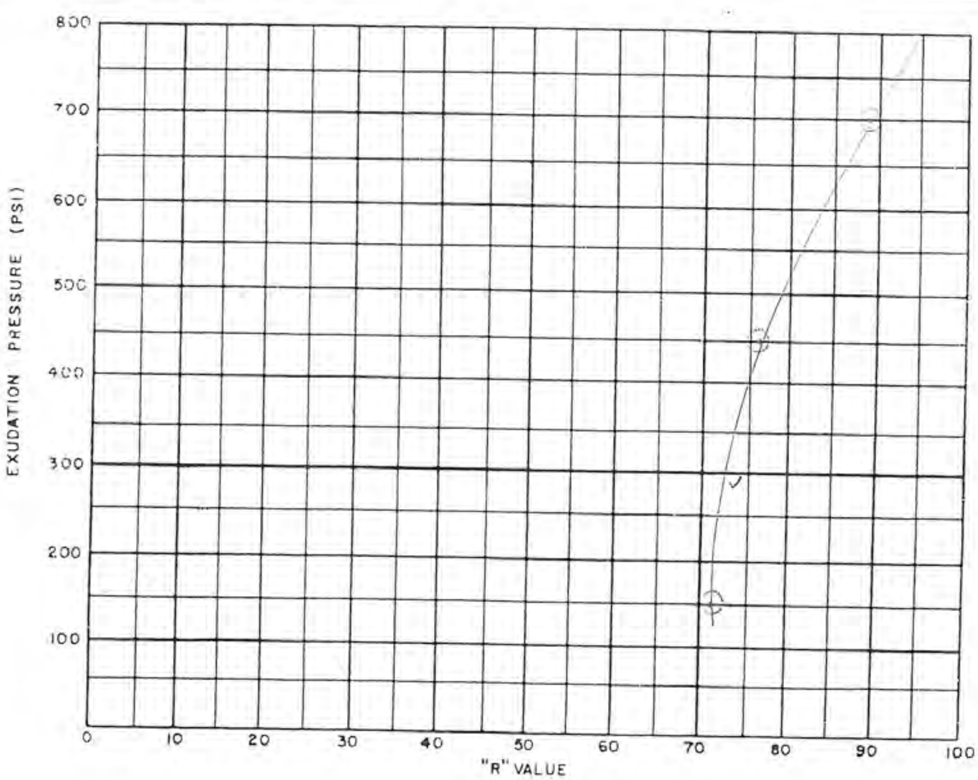
LL	PL	PI	LAB. NO
			08-258

SOIL CLASS & GROUP INDEX	PROJECT

FIELD IDENT				STATION
INITIAL MOISTURE				1"
WET		DRY		3/4"
DRY		TARE		3/8"
WT. WATER		WT. DRY		NO. 4

EXPANSION SPECIMEN	A	B	C	D
DIAL READING				
COVER REQUIRED—INCHES				

TIN NO.	REMARKS:	T-115A
	A1-R5(D, E, F)	"R" VALUE 73



WYOMING DEPARTMENT OF TRANSPORTATION

Form T-120
REVISED 8/99

Materials Testing Laboratory

SAMPLE TRANSMITTAL

☐ Metric
☒ English

☐ Preliminary
☒ Construction

☐ QC/QA

Lab # ______

Date Sampled: 4.28.08
Date Received: ______
Project Number: UW-Research
Road Section: Atlas Road
Resident Engineer: Huntington
at: UW
Pit or Source: Atlas Pit
County: Laramie

Sample Distribution

☐ Soils ☒ Aggregate ☐ Concrete ☐ Chemistry ☐ Geology

Multiple Samples ___ of ___

Sample Number(s): UW-A1-VWD
S # ______ TH # ______

Location (Belt, Stockpile, etc.): windrow
at: (Sta., kp., M.P., etc.) ______

Vertical Limits ______ to: ______

Horizontal Limits ______ to: ______

Quantity Represented ______

For Use As :

☐ Profile	☐ BSE	☐ PMP, Type ___ Grd. ___	☐ Conc. [illegible]
☐ Borrow	☐ CB, Grd. ___	☐ RPMP ___	☐ Conc. Med. Aggregate
☐ Topping	☐ PMB	☐ PMWC, Type ___	☐ Conc. Fine Aggregate
☐ Alkali	☐ CTB	☐ CCA, Type ___	☐ Conc. Cylinders
☐ Check Curve	☐ Filler	☐ Maint Type ___	☐ Conc. Beams
☐ Final Emb.	☐ Drain Gravel	☐ Check Design	☐ Port. Cement, Type ___
☒ Other: Surfacing			Type ___

Geosynthetics (Geogrid/Geotextile)

Product Name ______ Manufacturer ______

Remarks: Wash gradation; PL; LL; cohesion value; R-value; fractured faces; hydrometer (Geology)

Submitted By: George Huntington

g:\materials\shared\forms\soil & surf\t-120.xls

Reorder # FR-6042

WYOMING DEPARTMENT OF TRANSPORTATION
MATERIALS LABORATORY
REPORT OF TEST ON SURFACING MATERIALS

Form T-103B
Rev. 9-06
☐ English
☐ Metric

LABORATORY NO. 2008 - 0258 DATE REC'D 4-28-08
SUBMITTED BY G. Huntington AT U.W.
I.D. MARKS DATE SCREENED
SOURCE DATE SAMPLED
QUANTITY REPRESENTED LOCATION
FOR USE AS U.W Research PROJECT CO.

TEST RESULTS

SIEVE SIZE PASSING	RET. WT. LBS.	RET. WT. GRAMS	RET %	PASSING %	RET. WT. LBS.	RET. WT. GRAMS	RET. %	PASSING %	RET. WT. LBS.	RET. WT. GRAMS	RET %	PASSING %
MAX		413.7 304.4										"R" Value
3" (75 mm)												
2" (50 mm)												
1 1/2 (3.75 mm)				100.0								
1" (25 mm)	0.4		0.4	99.6								
3/4" (19 mm)	0.5		0.5	99.1								
1/2" (12.5 mm)	1.9		1.8	97.3								32
3/8" (9.50 mm)	2.4		2.2	95.1								58
#4 (4.75 mm)	18.7		17.4	77.7								268
#8 (2.36 mm)	83.5 / 83.8	59.6	11.3	66.4								1200
#16 (1.18 mm)		52.7	9.4	56.5								
#30 (600 um)		51.3	9.6	46.9								
#50 (300 um)		54.0	10.1	36.8								
#100 (150 um)		35.1	6.6	30.2								
#200 (75 um)		40.5	7.6	22.6								
PAN	10.7	120.0 / 120.5										
	107.7											(4)
LIQUID LIMIT	26											
PLASTICITY INDEX	11	A-2-6 (0)										
SAND EQUIVALENT												

Tests	Tech	Date
Screen		
LL - PI		
Wash	MAS	5-14
Gradation	MAS	5-19
Crush		
Crush Wash		
CR LL PI		
LAR		
SE		

REMARKS A1- Cont (D, E, F,) Comb

Wash Grad ✓
PI: LL: ✓
CV = 289 %
"R" Value = 41
Fracture Faces = Insufficient Mat. to performed Test.
Hydrometer = See Work sheet inside.
All Work Sheets Inside

WYOMING DEPARTMENT OF TRANSPORTATION — REV. 5/96

MATERIALS TESTING LABORATORY — h:\forms\soil&sur\T-DAVEG.XLS

REPORT OF NATURAL CEMENTATION OF AGGREGATE FINES

REPORT NO. ______ DATE 9/5/07

PROJECT NUMBER VWD, VWE & VWF SOURCE ______

ENGINEER ______ FOR USE AS ______

TEST RESULTS

$F + H^2O$ = ______

$F + M + H^2O$ = ______

MATERIAL + TARE = ______

O.D. = ______

TARE PAN ______ g.

$\frac{O.D.}{F + H^2O + 500 - F,M,H^2O}$ BULK

$\frac{O.D}{F + H^2O + O.D. - F,M,H^2O}$ APPARENT

	FLASK	F + M	$F + H^2O$
1	183.3	683.3	683.0
2	170.2	670.2	668.4
3	184.8	684.8	682.6

Moisture @ S.S.E.

MOISTURE SAMPLE FROM -4 S/G

TARE WEIGHT ______

WET WEIGHT ______ WT. OF MOISTURE ______

- DRY WEIGHT ______ ÷ DRY WEIGHT ______

= WT. OF MOISTURE ______ MOISTURE % @ S.S.D. ______

MOISTURE @ S.S.D + 5% FOR COMPACTION

MOISTURE @ COMPACTION

MOISTURE SAMPLE FROM EXCESS MATERIAL AFTER COMPACTION

TARE WEIGHT ______

WET WEIGHT 627 WT. OF MOISTURE 52.0

- DRY WEIGHT 575 ÷ DRY WEIGHT 575.0

= WT. OF MOISTURE 52.0 MOIST. % @ COMPACTION 9.0

	MACHINE LOAD				PSI
1	980	÷	4	=	245
2	1120	÷	4	=	280
3	1370	÷	4	=	343
AVG.				AVG.	289

MOLD: OILED ☑ UNOILED ☐

APPARENT S/G	2.589	BULK S/G	2.376
MOISTURE @ S.S.D		ABSORBTION %	3.500
MOISTURE @ COMPACTION	9.0%		

NOTES:30ml=2% moisture

______ TESTED BY ______ ENGINEER

GRAIN SIZE DISTRIBUTION TEST DATA

Project: U.W. Research
Project Number:
Client: G. Huntington

Sample Data

Source: UW-A1-CONT-(D,E,F)
Sample No.: 80288
Elev. or Depth:
Sample Length(in./cm.):
Location:
Description: Clayey sand

Mechanical Analysis Data

	Initial
Dry sample and tare=	1504.31
Tare =	0.00
Dry sample weight =	1504.31

Sample split on number 10 sieve
Split sample data:
Sample and tare = 81.95 Tare = .00 Sample weight = 81.95
Cumulative weight retained tare= .00
Tare for cumulative weight retained= .00

Sieve	Cumul. Wt. retained	Percent finer	Specification Limits, percent	Deviation, percent
3 inch	0.00	100.0	0.0 to 0.0	+ 100.0
1.5 inch	0.00	100.0	0.0 to 0.0	+ 100.0
.75 inch	0.00	100.0	0.0 to 0.0	+ 100.0
.375 inch	0.00	100.0	0.0 to 0.0	+ 100.0
# 4	3.73	99.8	0.0 to 0.0	+ 99.8
# 10	235.74	84.3		
# 20	14.18	69.7	0.0 to 0.0	+ 69.7
# 40	26.80	56.7	0.0 to 0.0	+ 56.7
# 100	40.69	42.4	0.0 to 0.0	+ 42.4
# 200	48.98	33.9	0.0 to 0.0	+ 33.9

Hydrometer Analysis Data

Separation sieve is #10
Percent -#10 based upon complete sample= 84.3
Weight of hydrometer sample: 83.28
Hygroscopic moisture correction:
Moist weight & tare = 185.55
Dry weight & tare = 184.27
Tare = 105.43
Hygroscopic moisture= 1.6 %
Calculated biased weight= 97.21
Automatic temperature correction
Composite correction at 20 deg C = -6.7

Meniscus correction only= 0
Specific gravity of solids= 2.669
Specific gravity correction factor= 0.996
Hydrometer type: 152H
Effective depth L= 16.294964 - 0.164 x Rm

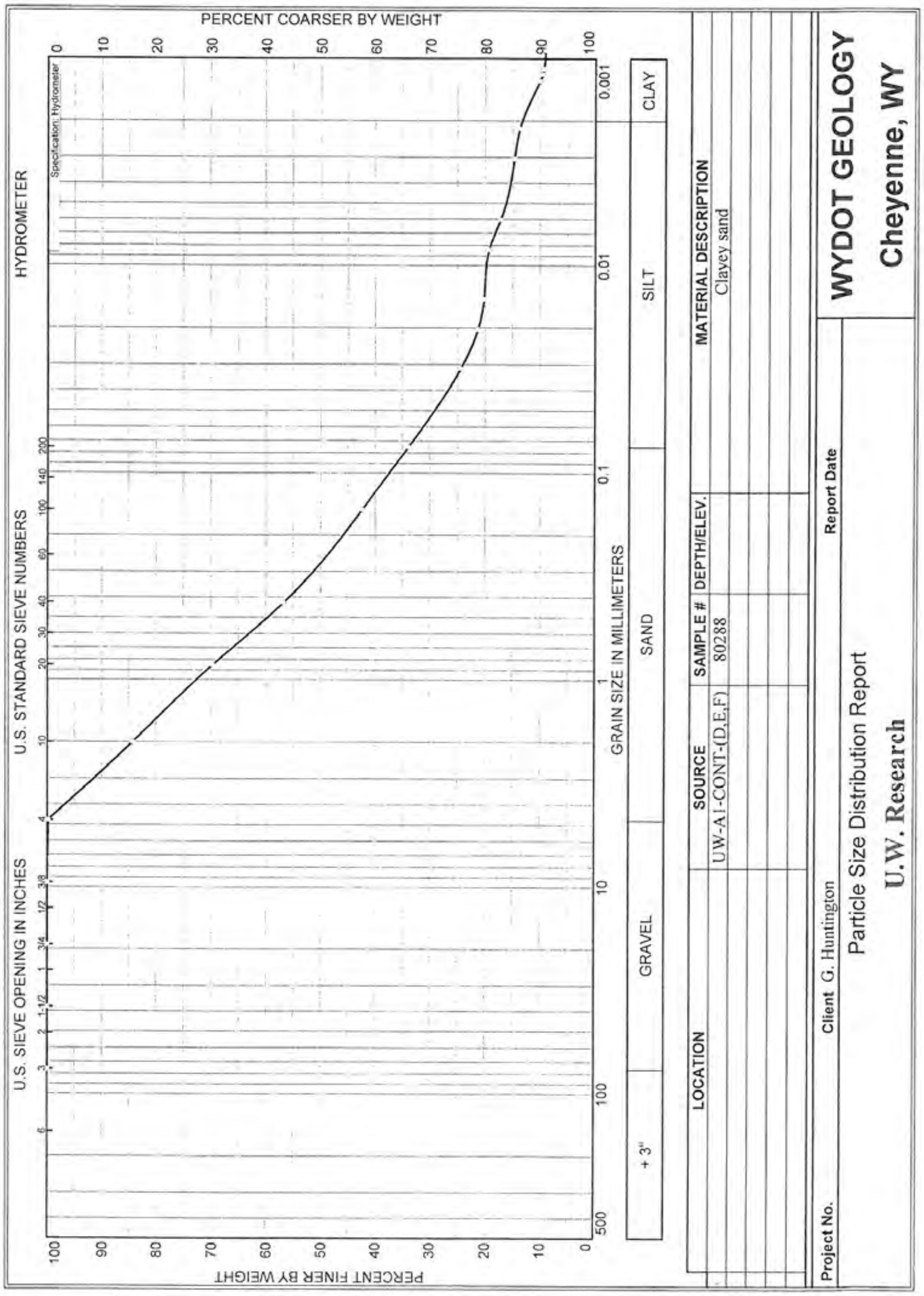
WYDOT GEOLOGY

Elapsed time, min	Temp, deg C	Actual reading	Corrected reading	K	Rm	Eff. depth	Diameter mm	Percent finer
2.00	22.5	30.0	23.8	0.0132	30.0	11.4	0.0314	24.4
5.00	22.5	27.0	20.8	0.0132	27.0	11.9	0.0203	21.3
10.00	22.0	26.0	19.7	0.0132	26.0	12.0	0.0145	20.2
30.00	22.5	25.0	18.8	0.0132	25.0	12.2	0.0084	19.3
60.00	22.5	23.0	16.8	0.0132	23.0	12.5	0.0060	17.2
240.00	22.5	20.5	14.3	0.0132	20.5	12.9	0.0031	14.7
480.00	22.5	19.5	13.3	0.0132	19.5	13.1	0.0022	13.7
1440.00	22.5	16.0	9.8	0.0132	16.0	13.7	0.0013	10.1
1680.00	22.5	15.5	9.3	0.0132	15.5	13.8	0.0012	9.6
1920.00	22.0	15.5	9.2	0.0132	15.5	13.8	0.0011	9.4
2880.00	22.5	15.0	8.8	0.0132	15.0	13.8	0.0009	9.1

Fractional Components

Gravel/Sand based on #4
Sand/Fines based on #200
% **+ 3"** = 0.0 % **GRAVEL** = 0.2 % **SAND** = 65.9
% **SILT** = 20.6 % **CLAY** = 13.3 (% **CLAY COLLOIDS** = 9.2)

D_{85}= 2.08 D_{60}= 0.51 D_{50}= 0.27
D_{30}= 0.05 D_{15}= 0.00 D_{10}= 0.00
C_c= 4.5094 C_u= 403.6618


PERCENT FINER BY WEIGHT
PERCENT COARSER BY WEIGHT
U.S. SIEVE OPENING IN INCHES
U.S. STANDARD SIEVE NUMBERS
HYDROMETER
GRAIN SIZE IN MILLIMETERS
+ 3"
GRAVEL
SAND
SILT
CLAY
LOCATION
SOURCE
UW-A1-CONT-(D,E,F)
SAMPLE #
80288
DEPTH/ELEV.
MATERIAL DESCRIPTION
Clayey sand
Project No.
Client G. Huntington
Report Date
Particle Size Distribution Report
U.W. Research
WYDOT GEOLOGY
Cheyenne, WY

Form T-115
Rev. 5/91

UW RESEARCH
ATLAS ROAD

WYOMING DEPARTMENT OF TRANSPORTATION

SOILS STABILOMETER WORK SHEET

TEST SPECIMEN	A	B	C	D
MOLD NO.	5A	37	114	
COMPACTOR AIR PRES.-PSI	350	300	200	
INITIAL MOIST.-%	—	—	—	
WATER ADDED-ML	100	120	110	
WATER ADDED-%	—	—	—	
MOIST AT COMPACTION %	[illegible]	[illegible]	9.2	
WET WEIGHT OF PAT-GMS	1140	1147	1172	
HEIGHT OF PAT-INCHES	2.57	2.50	2.46	
DENSITY-LB. PER CU. FT.	124.1	126.5	132.2	
STAB. Ph AT 1000 LBS	24	36	29	
2000 LBS.	61	89	75	
DISPLACEMENT	3.21	[illegible]	[illegible]	
"R" VALUE	56	35	44	
EXUDATION PRESS. PSI	600	250	350	

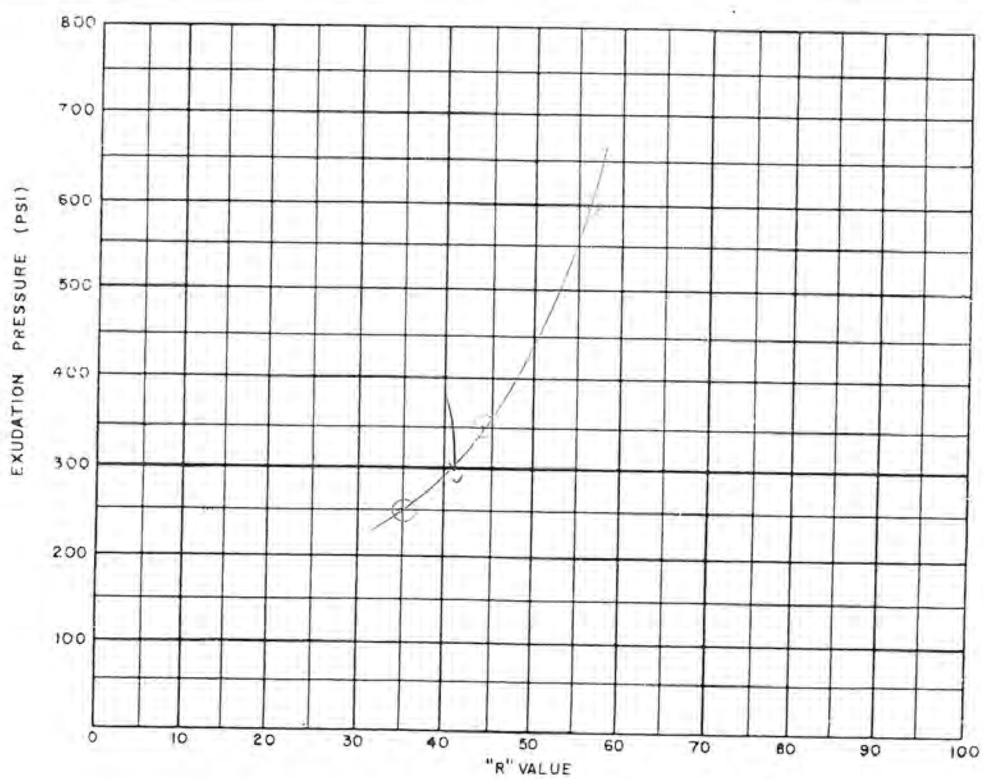
LL	PL	PI	LAB. NO
			08-258

SOIL CLASS & GROUP INDEX	PROJECT

FIELD IDENT.				STATION
INITIAL MOISTURE				1"
WET		DRY		3/4"
DRY		TARE		3/8"
WT. WATER		WT. DRY		NO. 4

EXPANSION SPECIMEN	A	B	C	D
DIAL READING	16	6	15	
COVER REQUIRED-INCHES				

TIN NO.	REMARKS:	T-115A
	A1 CONT (D, E, F) comb	"R" VALUE 41



WYOMING DEPARTMENT OF TRANSPORTATION

Materials Testing Laboratory

SAMPLE TRANSMITTAL

Form T-120
REVISED 8/99

☐ Metric ☒ English

☐ Preliminary ☒ Construction ☐ QC/QA

Lab # 08-23

Date Sampled 4-28-08 Date Received 5-19-08

Project Number UW-Research Road Section Atlas Road

Resident Engineer Huntington at: UW

Pit or Source Atlas ~~Pit~~ Stockpile County Laramie

Sample Distribution

☐ Soils ☒ Aggregate ☐ Concrete ☐ Chemistry ☐ Geology

Sample Number(s) UW-A2-RAPWA S # ______ TH # ______

Multiple Samples 1 of 1

Location (Belt, Stockpile, etc.) ______ at: (Sta., kp., M.P., etc.) ______

Vertical Limits ______ to: ______

Horizontal Limits ______ to: ______

Quantity Represented ______

For Use As :

☐ Profile	☐ BSE	☐ PMP, Type ____ Grd. ____	☐ Conc. Coarse Aggregate
☐ Borrow	☐ CB, Grd. ____	☐ RPMP ____	☐ Conc. Med. Aggregate
☐ Topping	☐ PMB	☐ PMWC, Type ____	☐ Conc. Fine Aggregate
☐ Alkali	☐ CTB	☐ CCA, Type ____	☐ Conc. Cylinders
☐ Check Curve	☐ Filler	☐ Maint. Type ____	☐ Conc. Beams
☐ Final Emb.	☐ Drain Gravel	☐ Check Design	☐ Port. Cement, Type ____
☒ Other Surfacing			Type ____

Geosynthetics (Geogrid/Geotextile)

Product Name ______ Manufacturer ______

Remarks: Asphalt content by chemical extraction; screened gradation; cohesion value; R-value

2589.8

1116.8

2503.6

Submitted By George Huntington

g:\materials\shared\forms\soil & surf-120.xls

Reorder # FR-6042

WYOMING DEPARTMENT OF TRANSPORTATION
MATERIALS LABORATORY
REPORT OF TEST ON SURFACING MATERIALS

Form T-103B
Rev. 9-06
☐ English
☐ Metric

LABORATORY NO. 2008 - 0258 DATE REC'D 4-28-08
SUBMITTED BY G. Huntington AT U.W.
I.D. MARKS DATE SCREENED
SOURCE DATE SAMPLED
QUANTITY REPRESENTED LOCATION
FOR USE AS U.W Research PROJECT CO.

TEST RESULTS

SIEVE SIZE PASSING	RET. WT. LBS.	RET. WT. GRAMS	RET %	PASSING %	RET. WT. LBS.	RET. WT. GRAMS	RET. %	PASSING %	RET. WT. LBS.	RET. WT. GRAMS	RET %	PASSING %
MAX		364.7										"R" Value
3" (75 mm)												
2" (50 mm)				100.0								
1 1/2 (3.75 mm)	2.3		2.1	97.9								
1" (25 mm)	3.6		3.2	94.7								
3/4" (19 mm)	2.7		2.4	92.3								
1/2" (12.5 mm)	13.6		12.3	80								240
3/8" (9.50 mm)	8.8		7.9	72.1								334
#4 (4.75 mm)	31.0		27.9	44.2								670
#8 (2.36 mm)	49.0	96.8	11.7	32.5								1200
#16 (1.18 mm)		86.1	10.4	22.1								
#30 (600 um)		72.3	8.8	13.3								
#50 (300 um)		61.1	7.4	5.9								
#100 (150 um)		30.4	3.7	2.2								
#200 (75 um)		11.7	1.4	0.8								
PAN	6.0	6.3										
	111.0											(4)
LIQUID LIMIT	— Asphalt in sample											
PLASTICITY INDEX	— " " "											
SAND EQUIVALENT	—											

Tests	Tech	Date
Screen	CS JJ	5-19
LL - PI		
Wash		
Gradation	MAS	5-20
Crush		
Crush Wash		
CR LL PI		
LAR		
SE		

REMARKS UW-A2-RAPW(A,B,C)

EXT. CHEM. See work sheet inside.
GRAD. See work sheet inside.
CV — Not performed (Asphalt in Sample)
"R" VALUE = 76

FORM T-215
REV. 4/95

WYOMING DEPARTMENT OF TRANSPORTATION
MATERIALS LABORATORY
EXTRACTION WORKSHEET

LABORATORY NO:	08-00023	DATE TESTED:	5/21/2008
ENGINEER:	HUNTINGTON	LOCATION:	LARAMIE
DATE RECEIVED:	5/19/2008	SOURCE:	ATLAS STOCKPILE
SAMPLED ID:	UW-A2-RAPWA	PROJECT NO:	UW RESEARCH
FOR USE:	RAP	SOILS & SURFACING LAB NO:	

(1) WT. OF OILED SAMPLE, PAN AND FILTER:	2589.8	(4) WT. OF UNOILED SAMPLE, PAN, AND FILTER:	2503.6
(2) TARE OF PAN AND FILTER:	1116.8	(5) TARE OF PAN AND FILTER:	1116.8
(3) WT. OF OILED SAMPLE: (1 - 2)	1473.0	(6) WT. OF UNOILED SAMPLE: (4 - 5) (1385.)	1386.8
(7) WT. OF OIL (3 - 6)	86.2	(8) % OIL: (7 / 3)*100	5.85
		THEO. OIL CONTENT:	
		WT. DRY AGG. AFTER WASH:	1289.4

NOTE: WHEN DOING A VACUUM EXTRACTION, ADD 50 GRAMS FOR FILTER AID.

	WT. RET.	% RET.	% PASSING		SPEC'S
37.5mm(1 1/2")					
25mm (1")					
19mm (3/4")					
12.6mm (1/2")	91.5	6.7	93.3		
9.5mm (3/8")	67.1	4.9	88.4		
4.75mm (#4)	345.8	24.9	65.5		
2.36mm (#8)	222.3	16.0	49.5		
1.18mm (#16)	155.5	11.2	36.3		
600µm (#30)	118.2	8.5	27.8		
300µm (#50)	108.6	7.8	20.0		
150µm (#100)	91.4	6.6	13.4		
75µm (#200)	62.4	4.5	8.9		
PAN	123.0				
25.6					
TOTAL					
	124.0	0.08			

ABSON EXTRACTION

KINEMATIC VISCOSITY:

ABSOLUTE VISCOSITY:

PENETRATION:

CHEMICAL: METHODB OVEN:

CALCULATIONS

RERUN:

REMARKS:

TESTED BY: KMM

Form T-115
Rev. 5/91

UW RESEARCH
ATLAS ROAD

WYOMING DEPARTMENT OF TRANSPORTATION

SOILS STABILOMETER WORK SHEET

TEST SPECIMEN	A	B	C	D
MOLD NO.	9	10	29	
COMPACTOR AIR PRES.-PSI	300	350	350	
INITIAL MOIST.-%	—	—	—	
WATER ADDED-ML	100	70	50	
WATER ADDED-%	—	—	—	
MOIST AT COMPACTION %	8.3	5.8	4.2	
WET WEIGHT OF PAT-GMS	1023	1029	1097	
HEIGHT OF PAT-INCHES	2.41	[illegible]	2.47	
DENSITY-LB. PER CU. FT.	125.7	117.8	129.1	
STAB. Ph AT 1000 LBS	11	9	8	
2000 LBS.	24	22	20	
DISPLACEMENT	5.22	4.78	5.31	
"R" VALUE	73	77	77	
EXUDATION PRESS. PSI	150	450	750	

LL	PL	PI	LAB. NO 08-258	
SOIL CLASS & GROUP INDEX			PROJECT	
FIELD IDENT.			STATION	
INITIAL MOISTURE			1"	
WET		DRY	3/4"	
DRY		TARE	3/8"	
WT. WATER		WT. DRY	NO. 4	

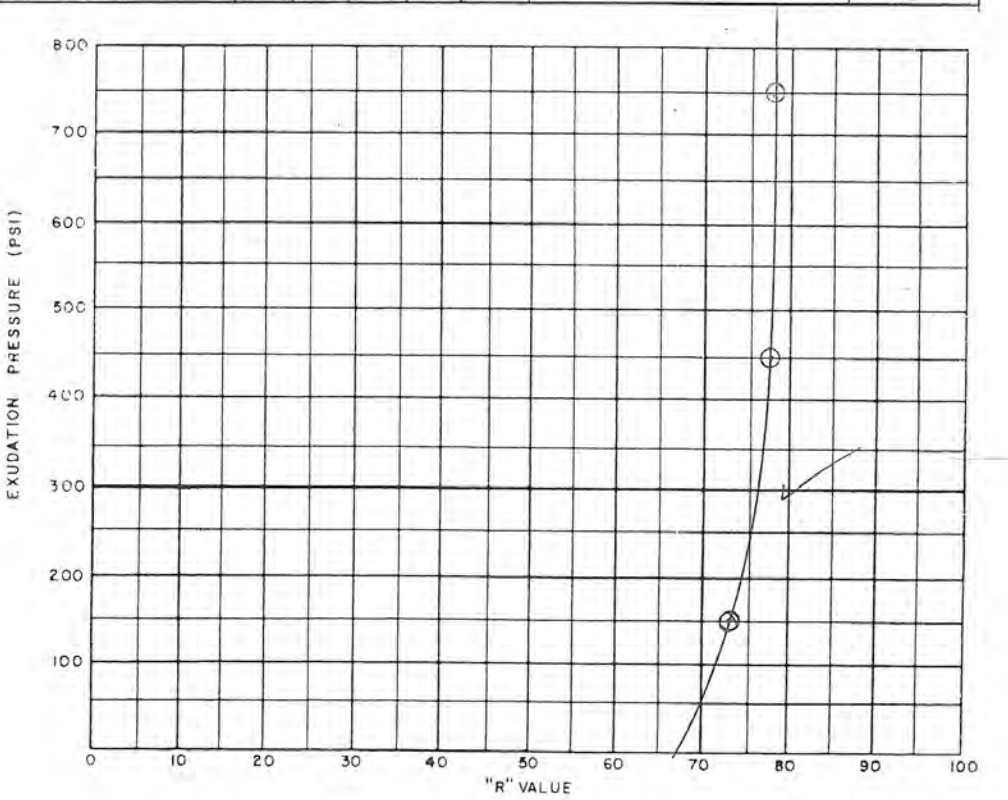
EXPANSION SPECIMEN	A	B	C	D
DIAL READING				
COVER REQUIRED-INCHES				

TIN NO.

REMARKS: A2 - RAPW (A,B,C)

T-115A

"R" VALUE 76



WYOMING DEPARTMENT OF TRANSPORTATION

Form T-120
REVISED 8/99

Materials Testing Laboratory
SAMPLE TRANSMITTAL

☐ Metric
☒ English

☐ Preliminary
☒ Construction

☐ QC/QA

Lab # 08-25

Date Sampled 4·28·08 Date Received 5-19-08

Project Number UW-Research Road Section Atlas Road

Resident Engineer Huntington at : UW

Pit or Source Atlas Road County Laramie

Sample Distribution

☐ Soils ☒ Aggregate ☐ Concrete ☐ Chemistry ☐ Geology

Multiple Samples 1 of 1

Sample Number(s) UW-A2-RSA S # ____ TH # ____

Location (Belt, Stockpile, etc.) Road Surface at: (Sta., kp., M.P., etc.) ____

Vertical Limits ____ to : ____

Horizontal Limits ____ to : ____

Quantity Represented ____

For Use As :

☐ Profile	☐ BSE	☐ PMP, Type ____ Grd. ____	☐ Conc. Coarse Aggregate
☐ Borrow	☐ CB, Grd. ____	☐ RPMP ____	☐ Conc. Med. Aggregate
☐ Topping	☐ PMB	☐ PMWC, Type ____	☐ Conc. Fine Aggregate
☐ Alkali	☐ CTB	☐ CCA, Type ____	☐ Conc. Cylinders
☐ Check Curve	☐ Filler	☐ Maint. Type ____	☐ Conc. Beams
☐ Final Emb.	☐ Drain Gravel	☐ Check Design	☐ Port. Cement, Type ____

☒ Other Surfacing Type ____

Geosynthetics (Geogrid/Geotextile)

Product Name ____ Manufacturer ____

Remarks: Asphalt Content by chemical extraction; screened gradation; cohesion value; R-value

2505.2 Combined RAP & Virgin

1018.2

2443.0

Submitted By George Huntington

g:\materials\shared\forms\soil & surf\-120.xls Reorder # FR-5042

WYOMING DEPARTMENT OF TRANSPORTATION
MATERIALS LABORATORY
REPORT OF TEST ON SURFACING MATERIALS

Form T-103B
Rev. 9-06
☐ English
☐ Metric

LABORATORY NO. 2008 - 0258 DATE REC'D 4-28-08
SUBMITTED BY G. Huntington AT U.W.
I.D. MARKS DATE SCREENED
SOURCE DATE SAMPLED
QUANTITY REPRESENTED LOCATION
FOR USE AS U.W Research PROJECT CO.

TEST RESULTS

SIEVE SIZE PASSING	RET. WT. LBS.	RET. WT. GRAMS	RET %	PASSING %	RET. WT. LBS.	RET. WT. GRAMS	RET. %	PASSING %	RET. WT. LBS.	RET. WT. GRAMS	RET %	PASSING %/ "R" Value
MAX		151.6										
3" (75 mm)												
2" (50 mm)												
1 1/2 (3.75 mm)				100.0								
1" (25 mm)	1.6		1.6	98.4								
3/4" (19 mm)	1.6		1.6	96.8								
1/2" (12.5 mm)	8.9,		8.7	88.1								142
3/8" (9.50 mm)	6.7		6.5	81.6								220
#4 (4.75 mm)	27.4		26.8	54.8								542
#8 (2.36 mm)	55.1 / 56.1	134.5	21.0	33.8								1200
#16 (1.18 mm)		90.0	14.1	19.7								
#30 (600 um)		56.7	8.8	10.9								
#50 (300 um)		37.5	5.8	5.1								
#100 (150 um)		17.9	2.8	2.3								
#200 (75 um)		8.5	1.3	1.0								
PAN	6.1	6.5										
	102.3											(4)
LIQUID LIMIT	—											
PLASTICITY INDEX	—											
SAND EQUIVALENT					Road Sample							

Tests	Tech	Date
Screen	CS JJ	5-19
LL - PI		
Wash		
Gradation	MAS	5-20
Crush		
Crush Wash		
CR LL PI		
LAR		
SE		

REMARKS UW-12-R5 (A,B,C)

Ext. Chem. = see worksheet inside
Grad. = see worksheet inside
Cl = not performed (asphalt in sampel)
"R" Value = 78
INplace Moisture = 3.4% (A)
4.3% (B)
4.2% (C)

FORM T-215
REV. 4/95

WYOMING DEPARTMENT OF TRANSPORTATION
MATERIALS LABORATORY
EXTRACTION WORKSHEET

LABORATORY NO:	08-00025	DATE TESTED:	5/22/2008
ENGINEER:	HUNTINGTON	LOCATION:	LARAMIE
DATE RECEIVED:	5/19/2008	SOURCE:	ATLAS ROAD
SAMPLED ID:	UW-A2-RSA	PROJECT NO:	UW RESEARCH
FOR USE:	RAP	SOILS & SURFACING LAB NO:	

(1) WT. OF OILED SAMPLE, PAN AND FILTER:	2505.2	(4) WT. OF UNOILED SAMPLE, PAN, AND FILTER:	2443
(2) TARE OF PAN AND FILTER:	1018.2	(5) TARE OF PAN AND FILTER:	1018.2
(3) WT. OF OILED SAMPLE: (1 - 2)	1487.0	(6) WT. OF UNOILED SAMPLE: (4 - 5) [illegible]	1424.8
(7) WT. OF OIL (3 - 6)	62.2	(8) % OIL: (7 / 3)*100	4.18
		THEO. OIL CONTENT:	
		WT. DRY AGG. AFTER WASH:	1272.1

NOTE: WHEN DOING A VACUUM EXTRACTION, ADD 50 GRAMS FOR FILTER AID.

	WT. RET.	% RET.	% PASSING		SPEC'S
37.5mm(1 1/2")					
25mm (1")			100.0		
19mm (3/4")	7.9	0.6	99.4		
12.6mm (1/2")	99.2	7.0	92.4		
9.5mm (3/8")	46.7	3.3	89.1		
4.75mm (#4)	302.4	21.2	67.9		
2.36mm (#8)	203.2	14.3	53.6		
1.18mm (#16)	156.7	11.0	42.6		
600μm (#30)	128.2	9.0	33.6		
300μm (#50)	125.7	8.8	24.8		
150μm (#100)	105.5	7.4	17.4		
75μm (#200)	87.2	6.1	11.3		
PAN	161.0				
28.3					
TOTAL					
	162.6	0.12			

ABSON EXTRACTION

KINEMATIC VISCOSITY:

ABSOLUTE VISCOSITY:

PENETRATION:

CHEMICAL: METHODB OVEN:

CALCULATIONS

RERUN:

REMARKS:

TESTED BY: KMM

Form T-115
Rev. 5/91

UW RESEARCH
ATLAS ROAD

WYOMING DEPARTMENT OF TRANSPORTATION

SOILS STABILOMETER WORK SHEET

TEST SPECIMEN	A	B	C	D
MOLD NO.	15H	4A	[illegible]	
COMPACTOR AIR PRES.-PSI	350	350	350	
INITIAL MOIST.-%	—	—	—	
WATER ADDED—ML	80	100	90	
WATER ADDED—%	—	—	—	
MOIST AT COMPACTION %	6.7	8.3	7.5	
WET WEIGHT OF PAT—GMS	1147	1152	1138	
HEIGHT OF PAT—INCHES	2.45	2.43	2.42	
DENSITY—LB. PER CU. FT.	132.9	133.3	132.5	
STAB. Ph AT 1000 LBS	6	12	10	
2000 LBS.	15	25	22	
DISPLACEMENT	4.35	4.41	[illegible]	
"R" VALUE	85	75	79	
EXUDATION PRESS. PSI	600	150	500	

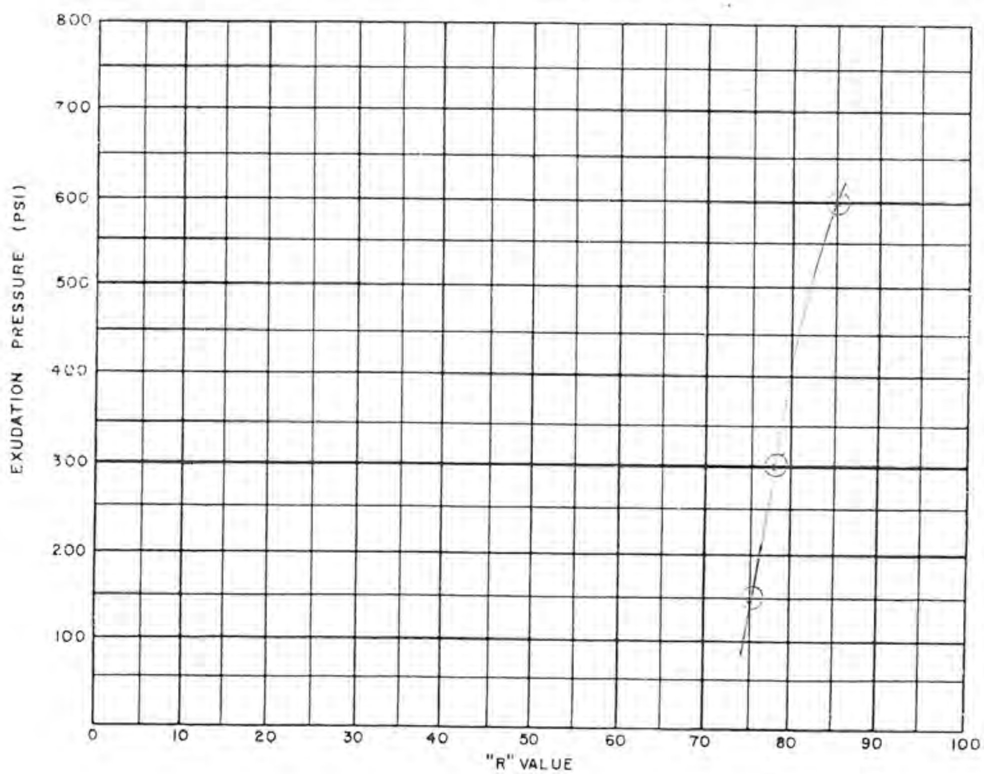
LL	PL	PI	LAB. NO
			08-258

SOIL CLASS & GROUP INDEX	PROJECT

FIELD IDENT.				STATION
INITIAL MOISTURE				1"
WET		DRY		3/4"
DRY		TARE		3/8"
WT. WATER		WT. DRY		NO. 4

EXPANSION SPECIMEN	A	B	C	D
DIAL READING				
COVER REQUIRED—INCHES				

TIN NO.	REMARKS:	T-115A "R" VALUE
	AZ-RS (A,B,C)	78



SOILS INPLACE MOISTURE SHEET

LAB. #
PROJECT # U.W. RESEARCH
GEOLOGIST HUNTINGTON
DATE 4-29-08
TECH:

SAMPLE I.D.	WET WT.	DRY WT.	WT.OF MOIST.	MOIST. %
UW-A2-RSA	209.9	203.0	6.9	3.4
UW-A2-RSB	211.6	202.9	8.7	4.3
UW-A2-RSC	187.6	180.0	7.6	4.2
UW-A1-RSD	186.5	179.7	6.8	3.8
UW-A1-RSE	217.7	210.9	3.2	1.5
UW-A1-RSF	221.3	215.3	6.0	2.8
UW-P1-RSJ	165.8	160.0	5.8	3.6
UW-P1-RSK	196.8	189.4	7.4	3.9
UW-P1-RSL	214.4	210.8	3.6	1.7

Wet wt. - Dry wt. = wt. of moisture
Wt. of Moisture / Dry wt. = moisture %

MAT/SOILS/SURF/FORMS/SOILS INPLACE MOISTURE SHEET

Form T-120
REVISED 8/99

WYOMING DEPARTMENT OF TRANSPORTATION
Materials Testing Laboratory
SAMPLE TRANSMITTAL

- [ ] Metric
- [x] English

- [ ] Preliminary
- [x] Construction
- [ ] QC/QA

Lab # ____

Date Sampled	4.28.08	Date Received	
Project Number	UW-Research	Road Section	Atlas Road
Resident Engineer	~~UW~~ Huntington	at:	UW
Pit or Source	Atlas Pit	County	Laramie

Sample Distribution

- [ ] Soils
- [x] Aggregate
- [ ] Concrete
- [ ] Chemistry
- [ ] Geology

Multiple Samples: 1 of 1

Sample Number(s) UW-A2-VWA S # ____ TH # ____

Location (Belt, Stockpile, etc.) Windrow at: (Sta., kp., M.P., etc.) ____

Vertical Limits ____ to: ____

Horizontal Limits ____ to: ____

Quantity Represented ____

For Use As :

[ ] Profile	[ ] BSE	[ ] PMP, Type ____ Grd. ____	[ ] Conc. Coarse Aggregate
[ ] Borrow	[ ] CB, Grd. ____	[ ] RPMP ____	[ ] Conc. Med. Aggregate
[ ] Topping	[ ] PMB	[ ] PMWC, Type ____	[ ] Conc. Fine Aggregate
[ ] Alkali	[ ] CTB	[ ] CCA, Type ____	[ ] Conc. Cylinders
[ ] Check Curve	[ ] Filler	[ ] Maint. Type ____	[ ] Conc. Beams
[ ] Final Emb.	[ ] Drain Gravel	[ ] Check Design	[ ] Port. Cement, Type ____
[x] Other Surfacing		Type ____	

Geosynthetics (Geogrid/Geotextile)

Product Name ____ Manufacturer ____

Remarks: Wash gradation; PL; LL; cohesion value; R-value; fractured faces; hydrometer (Geology)

Submitted By George Huntington

g:\materials\shared\forms\soil & sur\t-120.xls

Reorder # FR-5042

WYOMING DEPARTMENT OF TRANSPORTATION
MATERIALS LABORATORY
REPORT OF TEST ON SURFACING MATERIALS

Form T-103B
Rev. 9-06
☐ English
☐ Metric

LABORATORY NO. *2008 - 0258* DATE REC'D *4-28-08*
SUBMITTED BY *G. Huntington* AT *U. W.*
I.D. MARKS ______ DATE SCREENED ______
SOURCE ______ DATE SAMPLED ______
QUANTITY REPRESENTED ______ LOCATION ______
FOR USE AS *U. W Research* PROJECT ______ CO. ______

TEST RESULTS

SIEVE SIZE PASSING	RET. WT. LBS.	RET. WT. GRAMS	RET %	PASSING %	RET. WT. LBS.	RET. WT. GRAMS	RET. %	PASSING %	RET. WT. LBS.	RET. WT. GRAMS	RET %	PASSING %
___ MAX		372.2 258.2										"R" Value
3" (75 mm)												
2" (50 mm)												
1 1/2 (3.75 mm)												
1" (25 mm)				100.0								
3/4" (19 mm)	0.6		0.5	99.5								
1/2" (12.5 mm)	2.1		1.7	97.8								24
3/8" (9.50 mm)	2.8		2.3	95.5								54
#4 (4.75 mm)	21.4		17.5	78.0								264
#8 (2.36 mm)	94.9 / 95.3	45.6	9.5	68.5								1200
#16 (1.18 mm)		39.2	8.2	60.3								
#30 (600 um)		37.7	7.9	52.4								
#50 (300 um)		41.4	8.7	43.7								
#100 (150 um)		35.8	7.5	36.2								
#200 (75 um)		46.2	9.7	26.5								
PAN	11.6	125.6 / 126.3										
	122.2											(4)
LIQUID LIMIT	25											
PLASTICITY INDEX	9	A-2-4 (0)										
SAND EQUIVALENT												

Tests	Tech	Date
Screen	CS JJ	5-14
LL - PI	GE	5-14
Wash	MAS	5-14
Gradation	MAS	5-19
Crush		
Crush Wash		
CR LL PI		
LAR		
SE		

REMARKS *U.W. - A2 - VW (A, B, C,)*

Wash ✓
PI LL ✓
CV = 360 PSI
"R" Value = 78
Fracture Faces = 95.4 %
Hydrometer = See worksheet inside.

LAB NO. AZ-UW (ABC) PIT UW Research ENGINEER DATE TECH

LOCATION PROJECT

	A	B													
5:1 Ratio	Wt. Of sample	Weight of Flat & Elong. Particles	% F & E Particles	% retained weights	Weighted %		Wt. Of One or more fractured faces	% one or more F.F.	% retained weights	Weighted %		Wt. Of Two or more fractured faces	% Two or more F.F.	% retained weights	Wt %
SIEVE SIZE															
Coarse															
-3/4"+1/2"						[illegible]	[illegible]	[illegible]	0.100	9.[illegible]					
-1/2"+3/8"						[illegible]	[illegible]	92.5	0.105	[illegible].7					
-3/8"+#4						[illegible]	77.0	96.5	0.795	76.6					
Medium															
-3/4"+1/2"															
-1/2"+3/8"															
-3/8"+#4															
Fines															
-1/2"+3/8"															
-3/8"+#4															
Filler															
-1/2"+3/8"															
-3/8"+#4															
								95.[illegible]							
Weighted Total %										95.4					

Flat & Elongated Formula

(B / A) X 100 = %

To calculate the weighted %, the +#4 needs to be adjusted so when all the new retained weights of the +#4 are added together, they equal 100%. Multiply the % of flat & elong. times the % retained of that sieve. Then multiply that times each bin split if there are multiple stockpiles if necessary. Add the weighted %'s on the various sieve sizes and report.

Note:
Flat test = width to thickness
Elongated test = length to width
Flat & Elongated = length to thickness

Wt % = weighted %

Note: The sieve size containing less than 10% will use the same % of flat & elongated as the sieve above it or below it.

Fractured Face Formula:
P=[F/(F+N)] X 100

F= Fractured Faces
N= No fractured faces
P= Percent of fractured faces

flatelong.xls

WYOMING DEPARTMENT OF TRANSPORTATION
MATERIALS TESTING LABORATORY

REV. 5/96
h:\forms\soil&sur\T-DAVEG.XLS

REPORT OF NATURAL CEMENTATION OF AGGREGATE FINES

REPORT NO. ______ DATE 9/5/98
PROJECT NUMBER UW H2 VW (A,B,C) SOURCE ______
ENGINEER ______ FOR USE AS ______

TEST RESULTS

F + H²0 = ______
F + M + H²0 = ______
MATERIAL + TARE = ______
O.D. = ______

TARE PAN ____ g.

BULK = O.D. / (F + H²0 + 500 - F,M,H²0)

APPARENT = O.D / (F + H²0 + O.D. - F,M,H²0)

	FLASK	F + M	F + H²0
1	183.3	683.3	683.0
2	170.2	670.2	668.4
3	184.8	684.8	682.6

Moisture @ S.S.E.
MOISTURE SAMPLE FROM -4 S/G

TARE WEIGHT			
WET WEIGHT		WT. OF MOISTURE	
- DRY WEIGHT		÷ DRY WEIGHT	
= WT. OF MOISTURE		MOISTURE % @ S.S.D.	

MOISTURE @ S.S.D + 5% FOR COMPACTION

MOISTURE @ COMPACTION
MOISTURE SAMPLE FROM EXCESS MATERIAL AFTER COMPACTION

TARE WEIGHT			
WET WEIGHT	609.5	WT. OF MOISTURE	53.7
- DRY WEIGHT	555.8	÷ DRY WEIGHT	555.8
= WT. OF MOISTURE	53.7	MOIST. % @ COMPACTION	9.7

	MACHINE LOAD				PSI
1	1775	÷	4	=	444
2	1145	÷	4	=	286
3	1405	÷	4	=	351
AVG.	1081			AVG.	360 %

MOLD
OILED [✓]
UNOILED [ ]

APPARENT S/G	2.493	BULK S/G	2.287
MOISTURE @ S.S.D		ABSORBTION %	3.606%
MOISTURE @ COMPACTION	9.7%		

NOTES:30ml=2% moisture

______ TESTED BY ______ ENGINEER

GRAIN SIZE DISTRIBUTION TEST DATA

Project: U.W. Research
Project Number: Client: G. Huntington

Sample Data

Source: UW-A2-VW-(A,B,C)
Sample No.: 80287
Elev. or Depth: Sample Length(in./cm.):
Location:
Description: Clayey sand

Mechanical Analysis Data

Initial
Dry sample and tare= 1586.07
Tare = 0.00
Dry sample weight = 1586.07
Sample split on number 10 sieve
Split sample data:
Sample and tare = 87.07 Tare = .00 Sample weight = 87.07
Cumulative weight retained tare= .00
Tare for cumulative weight retained= .00

Sieve	Cumul. Wt. retained	Percent finer
3 inch	0.00	100.0
1.5 inch	0.00	100.0
.75 inch	0.00	100.0
.375 inch	0.00	100.0
# 4	3.83	99.8
# 10	210.10	86.8
# 20	12.40	74.4
# 40	23.99	62.9
# 100	38.64	48.3
# 200	49.07	37.9

Hydrometer Analysis Data

Separation sieve is #10
Percent -#10 based upon complete sample= 86.8
Weight of hydrometer sample: 88.64
Hygroscopic moisture correction:
Moist weight & tare = 191.02
Dry weight & tare = 189.51
Tare = 105.86
Hygroscopic moisture= 1.8 %
Calculated biased weight= 100.31
Automatic temperature correction
Composite correction at 20 deg C = -6.7

Meniscus correction only= 0
Specific gravity of solids= 2.685
Specific gravity correction factor= 0.992
Hydrometer type: 152H
Effective depth L= 16.294964 - 0.164 x Rm

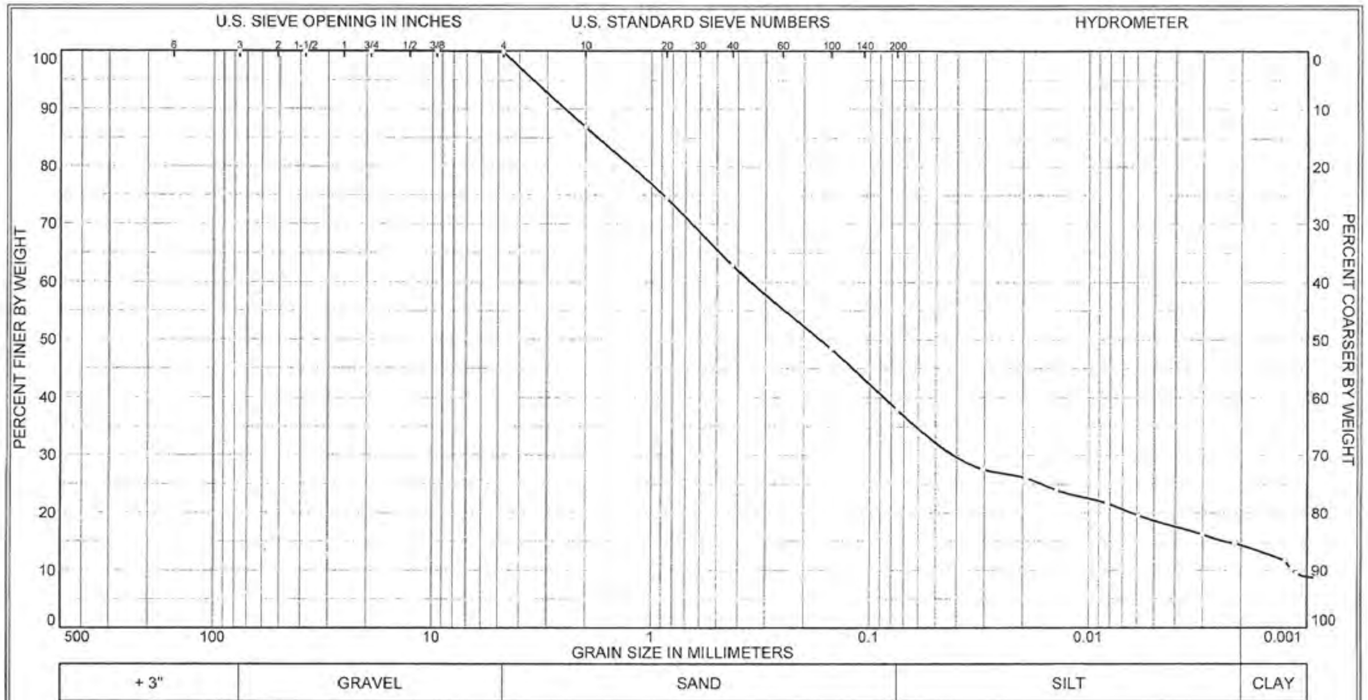
WYDOT GEOLOGY

Elapsed time, min	Temp, deg C	Actual reading	Corrected reading	K	Rm	Eff. depth	Diameter mm	Percent finer
2.00	22.5	34.0	27.8	0.0131	34.0	10.7	0.0303	27.5
5.00	22.5	32.5	26.3	0.0131	32.5	11.0	0.0194	26.0
10.00	22.0	30.5	24.2	0.0132	30.5	11.3	0.0140	23.9
30.00	22.5	28.0	21.8	0.0131	28.0	11.7	0.0082	21.6
60.00	22.0	26.0	19.7	0.0132	26.0	12.0	0.0059	19.5
240.00	22.5	22.5	16.3	0.0131	22.5	12.6	0.0030	16.2
480.00	22.5	21.0	14.8	0.0131	21.0	12.9	0.0021	14.7
1440.00	22.5	18.0	11.8	0.0131	18.0	13.3	0.0013	11.7
1680.00	22.5	16.5	10.3	0.0131	16.5	13.6	0.0012	10.2
1920.00	21.5	16.0	9.6	0.0133	16.0	13.7	0.0011	9.5
2880.00	22.5	15.0	8.8	0.0131	15.0	13.8	0.0009	8.7

Fractional Components

Gravel/Sand based on #4
Sand/Fines based on #200
% + 3" = 0.0 % GRAVEL = 0.2 % SAND = 61.9
% SILT = 23.5 % CLAY = 14.4 (% CLAY COLLOIDS = 8.8)

D_{85}= 1.76 D_{60}= 0.35 D_{50}= 0.17
D_{30}= 0.04 D_{15}= 0.00 D_{10}= 0.00
C_c= 4.2485 C_u= 301.4911



LOCATION	SOURCE	SAMPLE #	DEPTH/ELEV.	MATERIAL DESCRIPTION
	UW-A2-VW-(A,B,C)	80287		Clayey sand

Project No. **Client** G. Huntington **Report Date** 6/13/2008

Particle Size Distribution Report

U.W. Research

WYDOT GEOLOGY

Cheyenne, WY

Form T-115
Rev. 5/91

UW RESEARCH
ATLAS ROAD

WYOMING DEPARTMENT OF TRANSPORTATION

SOILS STABILOMETER WORK SHEET

TEST SPECIMEN	A	B	C	D
MOLD NO	55	9	101	
COMPACTOR AIR PRES.-PSI	350	350	350	
INITIAL MOIST.-%	—	—	—	
WATER ADDED-ML	20	90	65	
WATER ADDED-%	—	—	—	
MOIST AT COMPACTION %	6.7	7.5	5.4	
WET WEIGHT OF PAT-GMS	1118	1096	[illegible]	
HEIGHT OF PAT-INCHES	2.45	2.47	[illegible]	
DENSITY-LB. PER CU. FT.	129.8	125.1	124.6	
STAB. Ph AT 1000 LBS	12	16	[illegible]	
2000 LBS.	26	35	19	
DISPLACEMENT	3.63	3.49	4.00	
"R" VALUE	78	72	82	
EXUDATION PRESS. PSI	300	200	[illegible]	

LL	PL	PI	LAB. NO
			08-258

SOIL CLASS & GROUP INDEX

PROJECT

FIELD IDENT.

STATION

INITIAL MOISTURE

WET		DRY		1"
DRY		TARE		3/4"
WT WATER		WT DRY		3/8"
				NO. 4

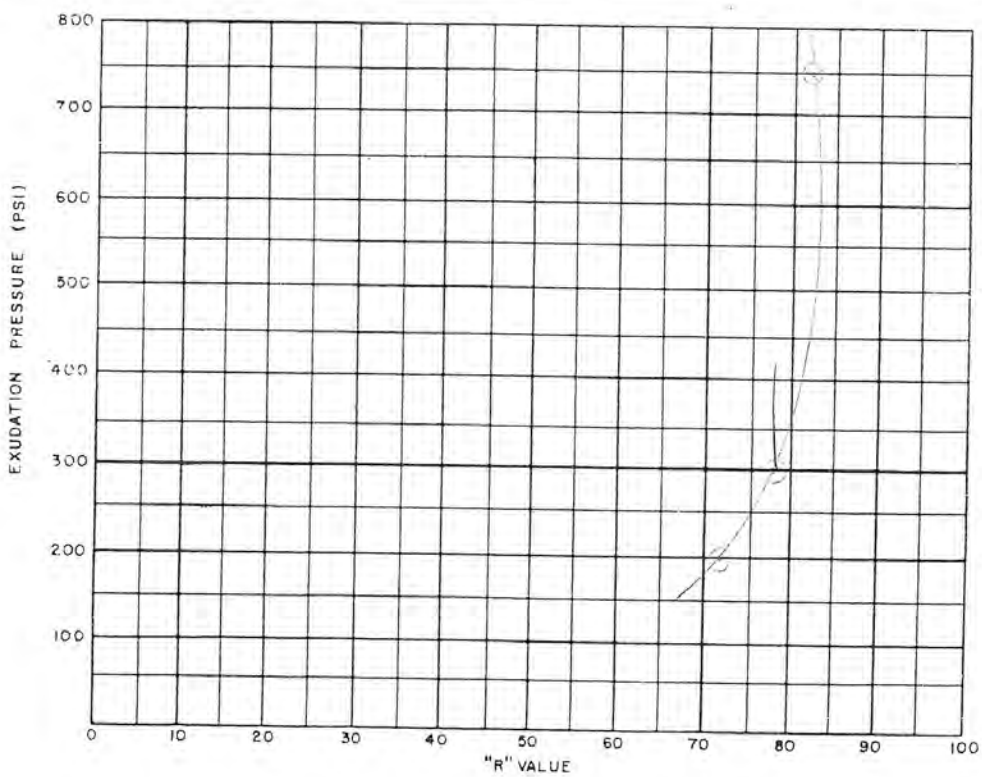
EXPANSION SPECIMEN	A	B	C	D
DIAL READING				
COVER REQUIRED-INCHES				

TIN NO.

REMARKS: A2-VW (A, B, C)

T-115A

"R" VALUE 78



LIQUID LIMIT AND PLASTIC INDEX TEST U. W. Research Lab# 08-0258

TECH:______ SURF:______ SOILS:______ DATE:______

LAB #	TIN #	WET WEIGHT	DRY WEIGHT	TIN TARE	# OF BLOWS	WEIGHT H20	WEIGHT DRY SOIL	% H20	CORR. % H20	PLASTIC INDEX	L.L. & P.I.	# OF BLOWS CORR. FACTOR
258 ABC	568	34.00	31.12	T D	17	2.88	11.12	25.9	24.7		25	14 = 0.933
UW-A2-VW	550	33.43	31.56	R O		1.87	11.56		16.2	8.5	9	15 = 0.940
258 O,M,N	570	34.97	31.61	I U	14	3.36	11.61	28.9	27.0		27	16 = 0.947
UW-P1-CONT	594	34.71	32.63	P B		2.08	12.63		16.5	10.5	11	17 = 0.954
258 G,H,I	517	36.73	33.14	L L	23	3.59	13.14	27.3	27.0		27	18 = 0.961
UW-A1-CONT	508	30.16	28.82	E E		1.34	8.82		15.2	11.8	12	19 = 0.967
258 J,K,L	541	35.94	32.26		19	3.69	12.26	30.02	29.0		29	20 = 0.973
UW-A1-CONT	509	36.03	34.13	D D		1.90	[illegible]		13.4	15.6	14	21 = 0.979
258 D,E,F	505	37.53	33.86	I I	19	3.67	13.86	26.48	25.4		26	22 = 0.985
UW-[illegible]-CONT	52.3	35.32	33.42	G G		1.90	13.42		14.2	11.4	11	23 = 0.990
				I I								24 = 0.995
				T T								25 = 1.000
												26 = 1.005
				T T								27 = 1.009
				I I								28 = 1.014
				N N								29 = 1.018
				S S								30 = 1.022
												31 = 1.026
				(=) (=)								32 = 1.030
												33 = 1.034
				20g 30g								34 = 1.038
												35 = 1.042
												36 = 1.045

TIN TARE TRIPLE DIGIT TINS = 20g DOUBLE DIGIT TINS = 30g % H20 = (WT. H20)/(WT. D.S.) X 100 LIQUID LIMIT - PLASTIC LIMIT = PLASTIC INDEX

LAB#________ PROJECT# UW- P1-VW (J,K,L) S.G. PIT NAME________

DATE 8-8-08

FINE AGGREGATE

FLASK & H2O #1 678.1

FLASK , MAT & H2O 975.1

MAT. & TARE 770.4

TARE #10 287.7

OVEN DRY 482.7

BULK S.G. = 482.7 / (678.1 +500.0- 975.1) (=) 482.7 / 208.0 (=) 2.378

APP. S.G. = 482.7 / (678.1 + 482.7 - 975.1) (=) 482.7 / 185.7 (=) 2.599

ABSORBTION = 500.0- 482.7 (=) 17.3 / 482.7 (=) 3.584

COARSE AGGREGATE

A = ________
B = ________
C = ________

BULK ________

APP. ________

% ABS ________

LAB#________ PROJECT# UW-A1-Porr (G,H,I) S.G. PIT NAME________

DATE 8-8-08

FINE AGGREGATE

FLASK & H2O #1 678.1

FLASK , MAT & H2O 970.7

MAT. & TARE 816.7

TARE #3 338.6

OVEN DRY 478.1

BULK S.G. = 478.1 / (678.1 +500.0- 970.7) (=) 478.1 / 207.4 (=) 2.305

APP. S.G. = 478.1 / (678.1 + 478.1 - 970.7) (=) 478.1 / 185.5 (=) 2.577

ABSORBTION = 500.0- 478.1 (=) 21.9 / 478.1 (=) 4.581

COARSE AGGREGATE

A = ________
B = ________
C = ________

BULK ________

APP. ________

% ABS ________

LAB#______ PROJECT# UW-A2 - 1/W (ABC) PIT NAME______

DATE 8-19-08

	FINE AGGREGATE		COARSE AGGREGATE
FLASK & H2O	678.1	Moist. Sample	A =
		200.0 g. SSD	B =
FLASK, MAT & H2O	967.1	192.9 O.D	C =
		7.1 = 3.681%	
MAT. & TARE	762.1		BULK
TARE	279.5		APP.
OVEN DRY	482.6		% ABS

BULK S.G. = —— / (678.1 +500.0- 967.1) (=) 482.6 / 211.0 (=) 2.287

APP. S.G. = —— / (678.1+ 482.6-967.1) (=) 482.6 / 193.6 (=) 2.493

ABSORBTION = 500.0- 482.6 / —— (=) 17.4 / 482.6 (=) 3.606

LAB#______ PROJECT# UW- P1 - CONT (O.M.N) PIT NAME______

DATE 8-19-08

	FINE AGGREGATE		COARSE AGGREGATE
FLASK & H2O	683.1	Moist Sample	A =
		200.0 g SSD	B =
FLASK, MAT & H2O	973.5	192.3	C =
		7.7 = 4.004 %	
MAT. & TARE	760.5		BULK
TARE	280.1		APP.
OVEN DRY	480.4		% ABS

BULK S.G. = —— / (683.1 +500.0- 973.5) (=) 480.4 / 209.6 (=) 2.292

APP. S.G. = —— / (683.1+ 480.4- 973.5) (=) 480.4 / 190.0 (=) 2.528

ABSORBTION = 500.0- 480.4 / —— (=) 19.6 / 480.4 (=) 4.080

LAB#__________ PROJECT# UW-A1-VW (D.S.F.) __________ PIT NAME__________

DATE 8-15-08

FINE AGGREGATE

COARSE AGGREGATE

FLASK & H2O	678.1	Moist Sample 200.0 g SSD	A =
FLASK , MAT & H2O	974.7	193.7 O.D	B =
		6.3 = 3.252 %	C =
MAT. & TARE	819.6		BULK
TARE	336.3		APP.
OVEN DRY	483.3		% ABS

BULK S.G. = — / (678.1 +500.0- 974.7) (=) 483.3 / 203.4 (=) 2.376

APP. S.G. = — / (678.1 + 483.3 − 974.7) (=) 483.3 / 186.7 (=) 2.589

ABSORBTION = 500.0- 483.3 / — (=) 16.7 / 483.3 (=) 3.455

LAB#__________ PROJECT#__________ PIT NAME__________

DATE__________

FINE AGGREGATE

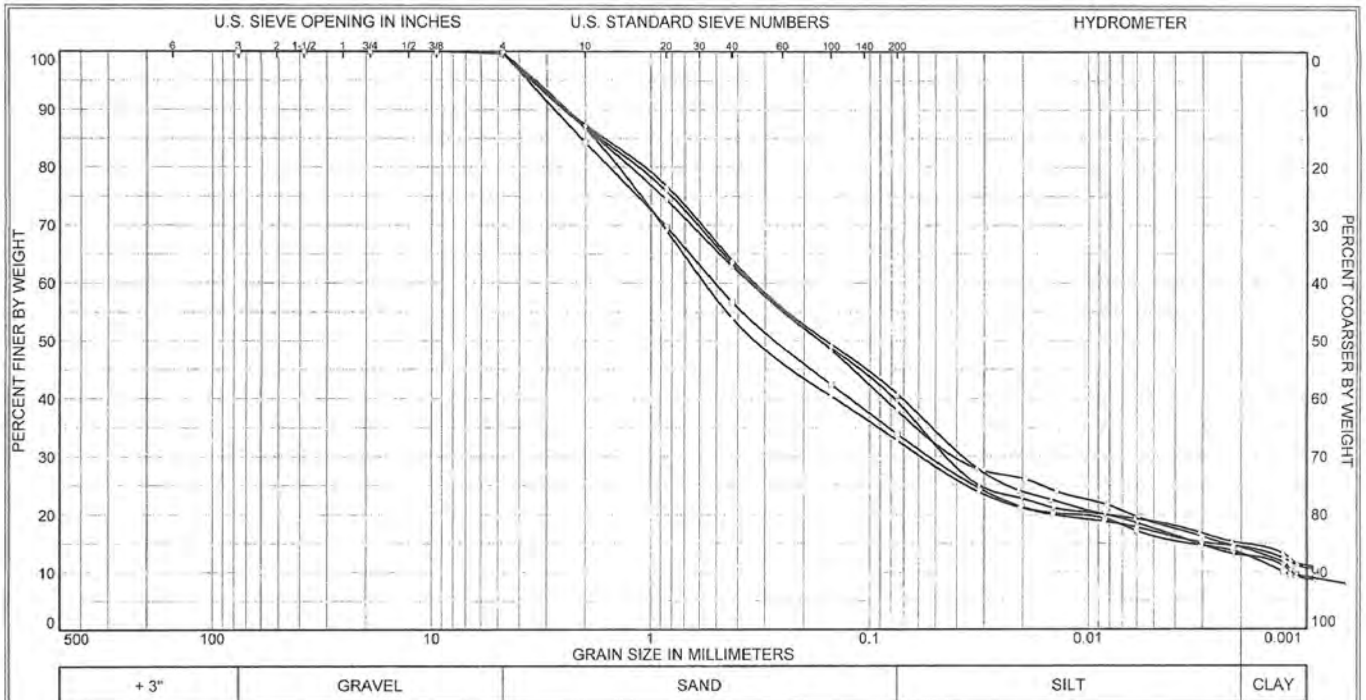
COARSE AGGREGATE

FLASK & H2O	______	A = ______
FLASK , MAT & H2O	______	B = ______
		C = ______
MAT. & TARE	______	BULK ______
TARE	______	APP. ______
OVEN DRY	______	% ABS ______

BULK S.G. = ______ / +500.0- (=) ______ (=) ______

APP. S.G. = ______ (=) ______ (=) ______

ABSORBTION = 500.0-______ (=) ______ (=) ______



LOCATION	SOURCE	SAMPLE #	DEPTH/ELEV.	MATERIAL DESCRIPTION
	UW-A2-VW-(A,B,C)	80287		Clayey sand
	UW-A1-CONT-(D,E,F)	80288		Clayey sand
	UW-A1-CONT-(G,H,I)	80289		Clayey sand
	UW-A1-CONT-(J,K,L)	80290		Clayey sand
	UW-P1-CONT-(O,M,N)	80291		Clayey sand

Project No. **Client** G. Huntington **Report Date** 6/13/2008

Particle Size Distribution Report

U.W. Research

WYDOT GEOLOGY

Cheyenne, WY

WYOMING DEPARTMENT OF TRANSPORTATION

Form T-120
REVISED 8/99

Materials Testing Laboratory

SAMPLE TRANSMITTAL

☐ Metric ☒ English

☐ Preliminary ☐ Construction ☐ QC/QA

Lab # ______

Date Sampled: 4-30-08

Date Received: ______

Project Number: HUNTINGTON

Road Section: PRY ROAD

Resident Engineer: UW RESEARCH

at: UW

Pit or Source: ATLAS

County: LARAMIE

Sample Distribution

☐ Soils ☐ Aggregate ☐ Concrete ☐ Chemistry ☐ Geology

Sample Number(s): UW-PI-CONTM S # ______ TH # ______

Multiple Samples: 1 of 1

Location (Belt, Stockpile, etc.): SURFACE at: (Sta., kp., M.P., etc.) ______

Vertical Limits ______ to: ______

Horizontal Limits ______ to: ______

Quantity Represented ______

For Use As:

☐ Profile ☐ BSE ☐ PMP Type ______ Grd ______ ☐ Conc. Coarse Aggregate

☐ Borrow ☐ CB, Grd. ______ ☐ RPMP ______ ☐ Conc. Med. Aggregate

☐ Topping ☐ PMB ☐ PMWC, Type ______ ☐ Conc. Fine Aggregate

☐ Alkali ☐ CTB ☐ CCA, Type ______ ☐ Conc. Cylinders

☐ Check Curve ☐ Filler ☐ Maint. Type ______ ☐ Conc. Beams

☐ Final Emb. ☐ Drain Gravel ☐ Check Design ☐ Port. Cement, Type ______

☒ Other: SURFACING Type ______

Geosynthetics (Geogrid/Geotextile)

Product Name ______ **Manufacturer** ______

Remarks: WASH GRADATION; PL:LL; COHESION VALUE; R-VALUE FRACTURED FACES; HYDROMETER (GEOLOGY)

Submitted By [signature]

g:\materials\shared\forms\soil & surf-120.xls

Reorder # FR-6042

WYOMING DEPARTMENT OF TRANSPORTATION
MATERIALS LABORATORY
REPORT OF TEST ON SURFACING MATERIALS

Form T-103B
Rev. 9-06
☐ English
☐ Metric

LABORATORY NO. 2008 - 0258 DATE REC'D 4-28-08
SUBMITTED BY G. Huntington AT U.W.
I.D. MARKS DATE SCREENED
SOURCE DATE SAMPLED
QUANTITY REPRESENTED LOCATION
FOR USE AS U.W Research PROJECT CO.

TEST RESULTS

SIEVE SIZE PASSING	RET. WT. LBS.	RET. WT. GRAMS	RET %	PASSING %	RET. WT. LBS.	RET. WT. GRAMS	RET. %	PASSING %	RET. WT. LBS.	RET. WT. GRAMS	RET %	PASSING %
MAX		320.1 233.7										"R" Value
3" (75 mm)												
2" (50 mm)												
1 1/2 (3.75 mm)				100.0								
1" (25 mm)	0.7		0.6	99.4								
3/4" (19 mm)	0.9		0.8	98.6								
1/2" (12.5 mm)	2.5		2.2	96.4								42
3/8" (9.50 mm)	3.1		2.7	93.7								74
#4 (4.75 mm)	20.2		17.6	76.1								284
#8 (2.36 mm)	86.6 / 87.1	46.3	11.0	65.1								1200
#16 (1.18 mm)		31.3	7.4	57.7								
#30 (600 um)		33.5	8.0	49.7								
#50 (300 um)		40.5	9.6	40.1								
#100 (150 um)		31.0	7.4	32.7								
#200 (75 um)		38.1	9.1	23.6								
PAN	13.0	99.4 / 99.4										
	114.5											(4)
LIQUID LIMIT	27											
PLASTICITY INDEX	11											
SAND EQUIVALENT												

Tests	Tech	Date
Screen	CS JJ	5-14
LL - PI	GE	5-14
Wash	MAS	5-14
Gradation	MAS	5-19
Crush		
Crush Wash		
CR LL PI		
LAR		
SE		

REMARKS U.W. - PI - CONT - (O, M, N,)
Wash ✓
PI:LL ✓
CV = 164 PSI
"R" Value = 26
Fracture Faces = Insufficient mat. to perform test.
Hydrometer = See worksheet inside.

GRAIN SIZE DISTRIBUTION TEST DATA

Project: U.W. Research
Project Number: **Client:** G. Huntington

Sample Data

Source: UW-P1-CONT-(O,M,N)
Sample No.: 80291
Elev. or Depth: **Sample Length(in./cm.):**
Location:
Description: Clayey sand

Mechanical Analysis Data

	Initial
Dry sample and tare=	1371.54
Tare =	0.00
Dry sample weight =	1371.54

Sample split on number 10 sieve
Split sample data:
Sample and tare = 78.98 Tare = .00 Sample weight = 78.98
Cumulative weight retained tare= .00
Tare for cumulative weight retained= .00

Sieve	Cumul. Wt. retained	Percent finer
# 4	4.23	99.7
# 10	179.41	86.9
# 20	10.02	75.9
# 40	21.44	63.3
# 100	34.84	48.6
# 200	43.11	39.5

Hydrometer Analysis Data

Separation sieve is #10
Percent -#10 based upon complete sample= 86.9
Weight of hydrometer sample: 80.54
Hygroscopic moisture correction:
Moist weight & tare = 184.16
Dry weight & tare = 182.63
Tare = 105.38
Hygroscopic moisture= 2.0 %
Calculated biased weight= 90.88
Automatic temperature correction
Composite correction at 20 deg C = -6.7

Meniscus correction only= 0
Specific gravity of solids= 2.685
Specific gravity correction factor= 0.992
Hydrometer type: 152H
Effective depth L= 16.294964 - 0.164 x Rm

Elapsed time, min	Temp, deg C	Actual reading	Corrected reading	K	Rm	Eff. depth	Diameter mm	Percent finer
2.00	22.5	29.0	22.8	0.0131	29.0	11.5	0.0315	24.9
5.00	22.5	27.0	20.8	0.0131	27.0	11.9	0.0202	22.7
10.00	22.5	25.5	19.3	0.0131	25.5	12.1	0.0144	21.1

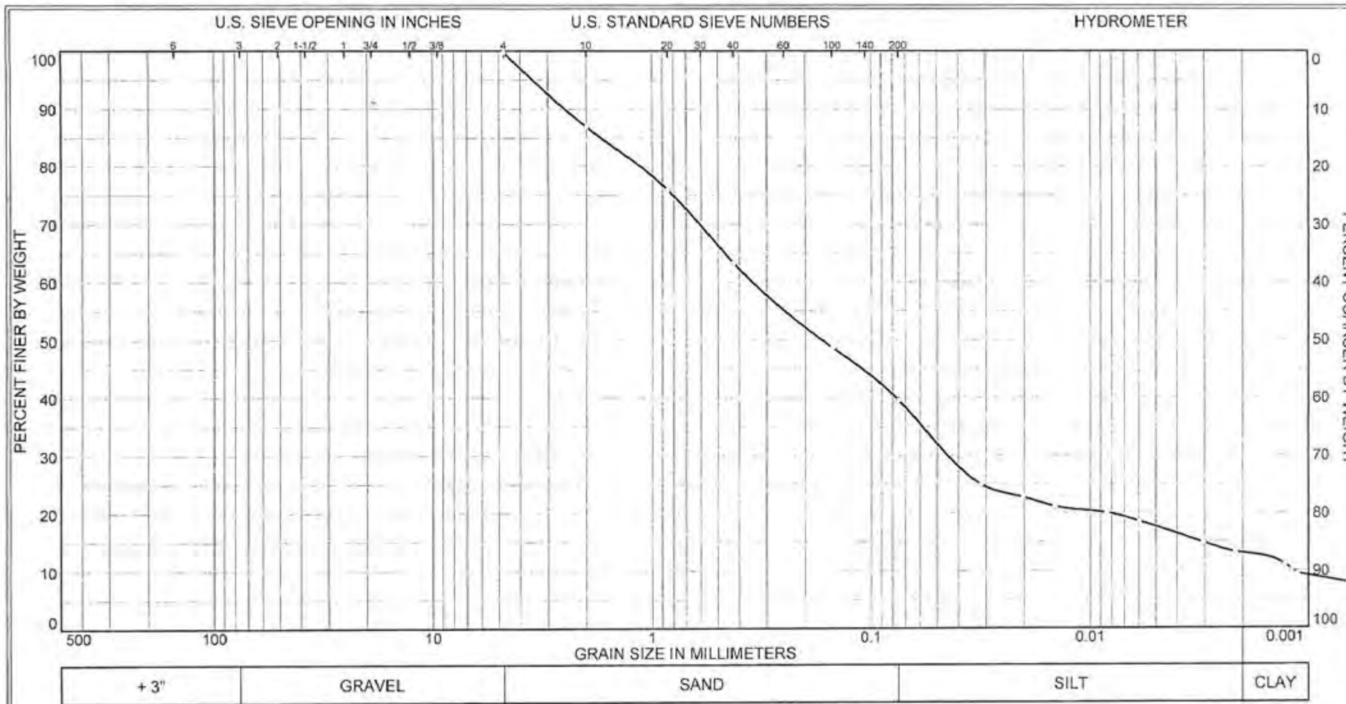
WYDOT GEOLOGY

Elapsed time, min	Temp, deg C	Actual reading	Corrected reading	K	Rm	Eff. depth	Diameter mm	Percent finer
30.00	22.5	24.5	18.3	0.0131	24.5	12.3	0.0084	20.0
60.00	23.0	23.0	17.0	0.0130	23.0	12.5	0.0059	18.5
240.00	23.5	19.5	13.6	0.0129	19.5	13.1	0.0030	14.8
480.00	23.5	18.0	12.1	0.0129	18.0	13.3	0.0022	13.2
1440.00	22.0	16.5	10.2	0.0132	16.5	13.6	0.0013	11.1
1680.00	22.5	15.5	9.3	0.0131	15.5	13.8	0.0012	10.2
1920.00	22.0	15.0	8.7	0.0132	15.0	13.8	0.0011	9.5
5760.00	22.0	13.5	7.2	0.0132	13.5	14.1	0.0007	7.9

Fractional Components

Gravel/Sand based on #4
Sand/Fines based on #200
% **+ 3" =** % **GRAVEL =** % **SAND =** 60.2
% **SILT =** 26.5 % **CLAY =** 13.0 **(% CLAY COLLOIDS =** 9.2**)**

D_{85}= 1.72 D_{60}= 0.35 D_{50}= 0.17
D_{30}= 0.05 D_{15}= 0.00 D_{10}= 0.00
C_c= 4.986 C_u= 299.7085



LOCATION	SOURCE	SAMPLE #	DEPTH/ELEV.	MATERIAL DESCRIPTION
	UW-P1-CONT-(O,M,N)	80291		Clayey sand

Project No. **Client** G. Huntington **Report Date**

Particle Size Distribution Report

U.W. Research

WYDOT GEOLOGY

Cheyenne, WY

WYOMING DEPARTMENT OF TRANSPORTATION
MATERIALS TESTING LABORATORY

REV. 5/96
h:\forms\soil&sur\T-DAVEG.XLS

REPORT OF NATURAL CEMENTATION OF AGGREGATE FINES

REPORT NO. ______
PROJECT NUMBER: UW - PI - CONT (O, M, N)
ENGINEER ______

DATE: 8/20/08
SOURCE ______
FOR USE AS: UW Research

TEST RESULTS

F + H²0 = ______
F + M + H²0 = ______
MATERIAL + TARE = ______
O.D. = ______

TARE PAN ______ g.

$$\text{BULK} = \frac{\text{O.D.}}{\text{F} + \text{H}^2\text{0} + 500 - \text{F,M,H}^2\text{0}}$$

$$\text{APPARENT} = \frac{\text{O.D}}{\text{F} + \text{H}^2\text{0} + \text{O.D.} - \text{F,M,H}^2\text{0}}$$

	FLASK	F + M	F + H²0
1	183.3	683.3	683.0
2	170.2	670.2	668.4
3	184.8	684.8	682.6

Moisture @ S.S.E.

MOISTURE SAMPLE FROM -4 S/G

TARE WEIGHT			
WET WEIGHT		WT. OF MOISTURE	
- DRY WEIGHT		÷ DRY WEIGHT	
= WT. OF MOISTURE		MOISTURE % @ S.S.D.	

MOISTURE @ S.S.D + 5% FOR COMPACTION

MOISTURE @ COMPACTION

MOISTURE SAMPLE FROM EXCESS MATERIAL AFTER COMPACTION

TARE WEIGHT			
WET WEIGHT	723.0	WT. OF MOISTURE	67.6
- DRY WEIGHT	655.4	÷ DRY WEIGHT	655.4
= WT. OF MOISTURE	67.6	MOIST. % @ COMPACTION	10.3

	MACHINE LOAD				PSI
1	820	÷	4	=	205
2	540	÷	4	=	135
3	607	÷	4	=	152
AVG.				AVG.	164 PSI

MOLD
OILED [✓]
UNOILED [ ]

APPARENT S/G	2.528	BULK S/G	2.292
MOISTURE @ S.S.D		ABSORBTION %	4.080
MOISTURE @ COMPACTION	10.3		

NOTES:30ml=2% moisture

______ TESTED BY

______ ENGINEER

Form T-115
Rev. 5/91

UW RESEARCH

ATLAS ROAD

WYOMING DEPARTMENT OF TRANSPORTATION

SOILS STABILOMETER WORK SHEET

TEST SPECIMEN	A	B	C	D
MOLD NO.	104	[illegible]	39	
COMPACTOR AIR PRES.-PSI	300	100	20	
INITIAL MOIST.—%	—	—	—	
WATER ADDED—ML	100	140	120	
WATER ADDED—%	—	—	—	
MOIST AT COMPACTION %	8.3	11.7	9.9	
WET WEIGHT OF PAT—GMS	1161	1161	1094	
HEIGHT OF PAT—INCHES	2.49	2.60	2.49	
DENSITY—LB. PER CU. FT.	130.5	121.1	121.1	
STAB. Ph AT 1000 LBS	26	49	33	
2000 LBS.	76	119	97	
DISPLACEMENT	4.16	4.02	4.27	
"R" VALUE	40	12/20	26	
EXUDATION PRESS. PSI	600	150	300	

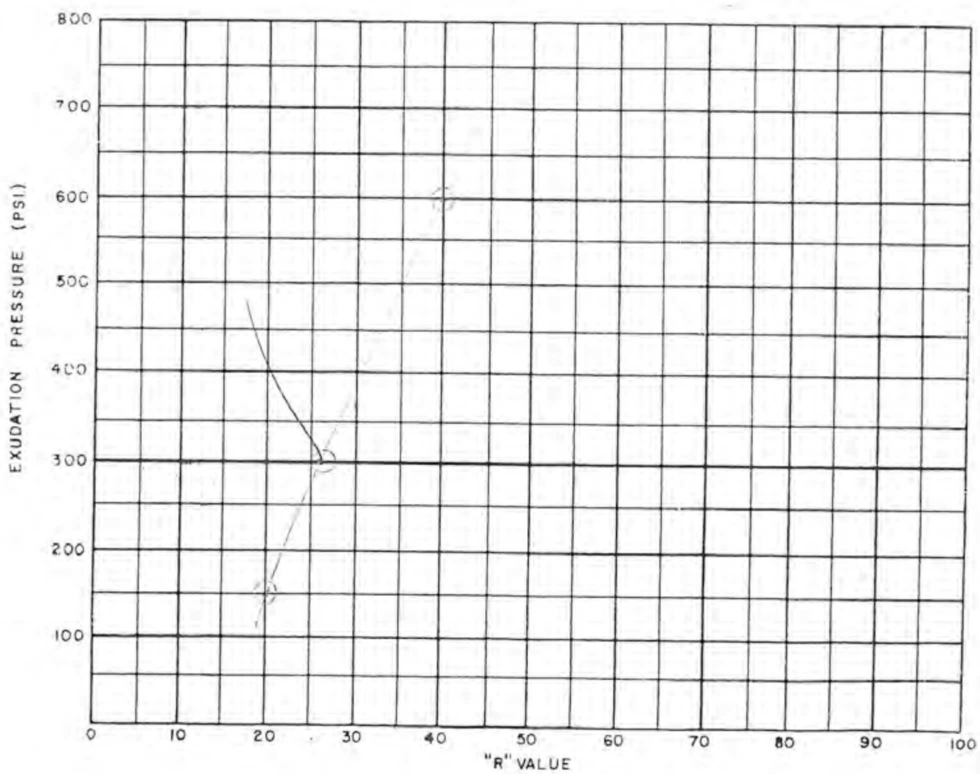
LL	PL	PI	LAB. NO
			08-258

SOIL CLASS & GROUP INDEX	PROJECT

FIELD IDENT.				STATION
INITIAL MOISTURE				1"
WET		DRY		3/4"
DRY		TARE		3/8"
WT. WATER		WT. DRY		NO. 4

EXPANSION SPECIMEN	A	B	C	D
DIAL READING	6	15	92	
COVER REQUIRED—INCHES				

TIN NO.	REMARKS:	T-115A	
	PI - CONT (O, M, N)	"R" VALUE 26	



WYOMING DEPARTMENT OF TRANSPORTATION
Materials Testing Laboratory
SAMPLE TRANSMITTAL

Form T-120
REVISED 8/99

- [ ] Metric
- [x] English
- [ ] Preliminary
- [ ] Construction
- [ ] QC/QA

Lab # 08-22

Date Sampled 4-29-08 Date Received 5-19-08

Project Number UW RESEARCH Road Section PRV ROAD

Resident Engineer HUNTINGTON at: UW

Pit or Source ATLAS PIT County LARAMIE

Sample Distribution

- [ ] Soils
- [ ] Aggregate
- [ ] Concrete
- [ ] Chemistry
- [ ] Geology

Sample Number(s) UW-PI-RAPWL S # ______ TH # ______

Multiple Samples 1 of 1

Location (Belt, Stockpile, etc.) WINDROW at: (Sta., kp., M.P., etc.) ______

Vertical Limits ______ to: ______

Horizontal Limits ______ to: ______

Quantity Represented ______

For Use As :

- [ ] Profile
- [ ] BSE
- [ ] PMP Type ______ Grd. ______
- [ ] Conc. Coarse Aggregate
- [ ] Borrow
- [ ] CB, Grd. ______
- [ ] RPMP ______
- [ ] Conc. Med. Aggregate
- [ ] Topping
- [ ] PMB
- [ ] PMWC, Type ______
- [ ] Conc. Fine Aggregate
- [ ] Alkali
- [ ] CTB
- [ ] CCA, Type ______
- [ ] Conc. Cylinders
- [ ] Check Curve
- [ ] Filler
- [ ] Maint. Type ______
- [ ] Conc. Beams
- [ ] Final Emb.
- [ ] Drain Gravel
- [ ] Check Design
- [ ] Port. Cement, Type ______
- [x] Other SURFACING Type ______

Geosynthetics (Geogrid/Geotextile)

Product Name ______ **Manufacturer** ______

Remarks: ASPHALT CONTENT BY CHEMICAL EXTRACTION
SCREENED GRADATION; COHESION VALUE; R-VALUE
2541.2
1105.8
2456.8

Submitted By [signature]

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Reorder # FR-6042

WYOMING DEPARTMENT OF TRANSPORTATION
MATERIALS LABORATORY
REPORT OF TEST ON SURFACING MATERIALS

Form T-103B
Rev. 9-06
☐ English
☐ Metric

LABORATORY NO. 2005 - 0258 DATE REC'D 4-28-08
SUBMITTED BY G. Huntington AT U.W.
I.D. MARKS ______ DATE SCREENED ______
SOURCE ______ DATE SAMPLED ______
QUANTITY REPRESENTED ______ LOCATION ______
FOR USE AS U.W Research PROJECT ______ CO. ______

TEST RESULTS

SIEVE SIZE PASSING	RET. WT. LBS.	RET. WT. GRAMS	RET %	PASSING %	RET. WT. LBS.	RET. WT. GRAMS	RET. %	PASSING %	RET. WT. LBS.	RET. WT. GRAMS	RET %	PASSING % / "R" Value
___ MAX		312.9										
3" (75 mm)												
2" (50 mm)												
1 1/2 (3.75 mm)				100.0								
1" (25 mm)	1.9		1.7	98.3								
3/4" (19 mm)	2.7		2.5	95.8								
1/2" (12.5 mm)	13.5		12.3	83.5								198
3/8" (9.50 mm)	8.5		7.7	75.8								270
#4 (4.75 mm)	28.5		26.0	49.8								602
#8 (2.36 mm)	54.2 / 54.6	126.3	20.2	29.6								1200
#16 (1.18 mm)		79.9	12.7	16.9								
#30 (600 um)		52.9	8.4	8.5								
#50 (300 um)		34.6	5.5	3.0								
#100 (150 um)		12.6	2.0	1.0								
#200 (75 um)		3.9	0.6	0.4								
PAN	2.5	2.6										
	109.7											(4)
LIQUID LIMIT	— Asphalt in Sample											
PLASTICITY INDEX	— " " "											
SAND EQUIVALENT												

Tests	Tech	Date
Screen	CS JJ	5-19
LL - PI		
Wash		
Gradation	MAS	5-20
Crush		
Crush Wash		
CR LL PI		
LAR		
SE		

REMARKS UW-PI-RAPW(J,K,L)

EXT. CHEM. (See work sheet inside)
GRAD. (See work sheet inside)
CV = not performed (Asphalt in sample)
"R" VALUE = 79

FORM T-215
REV. 4/95

WYOMING DEPARTMENT OF TRANSPORTATION
MATERIALS LABORATORY
EXTRACTION WORKSHEET

LABORATORY NO:	08-00022	DATE TESTED:	5/21/2008
ENGINEER:	HUNTINGTON	LOCATION:	LARAMIE
DATE RECEIVED:	5/19/2008	SOURCE:	ATLAS STOCKPILE
SAMPLED ID:	UW-PL-RAPWL	PROJECT NO:	UW RESEARCH
FOR USE:	RAP	SOILS & SURFACING LAB NO:	

(1) WT. OF OILED SAMPLE, PAN AND FILTER:	2541.2	(4) WT. OF UNOILED SAMPLE, PAN, AND FILTER:	2456.8
(2) TARE OF PAN AND FILTER:	1105.8	(5) TARE OF PAN AND FILTER:	1105.8
(3) WT. OF OILED SAMPLE: (1 - 2)	1435.4	(6) WT. OF UNOILED SAMPLE: (4 - 5) (13477)	1351.0
(7) WT. OF OIL (3 - 6)	84.4	(8) % OIL: (7 / 3)*100	5.88
		THEO. OIL CONTENT:	
		WT. DRY AGG. AFTER WASH:	1350.2

NOTE: WHEN DOING A VACUUM EXTRACTION, ADD 50 GRAMS FOR FILTER AID.

	WT. RET.	% RET.	% PASSING		SPEC'S
37.5mm(1 1/2")					
25mm (1")					
19mm (3/4")			100.0		
12.6mm (1/2")	104.1	7.7	[illegible]		
9.5mm (3/8")	57.6	4.3	88.0		
4.75mm (#4)	325.4	24.1	65.9		
2.36mm (#8)	210.1	15.6	48.3		
1.18mm (#16)	159.7	11.8	36.5		
600μm (#30)	120.5	8.9	27.6		
300μm (#50)	107.9	7.8	19.8		
150μm (#100)	84.5	6.3	13.5		
75μm (#200)	56.3	4.2	9.3		
PAN	126.0				
25.2					
TOTAL					
	127.9	0.15			

ABSON EXTRACTION

KINEMATIC VISCOSITY:

ABSOLUTE VISCOSITY:

PENETRATION:

CHEMICAL: METHODB OVEN:

CALCULATIONS

RERUN:

REMARKS:

TESTED BY: KMM

Form T-115
Rev. 5/91

UW RESEARCH
ATLAS ROAD

WYOMING DEPARTMENT OF TRANSPORTATION

SOILS STABILOMETER WORK SHEET

TEST SPECIMEN	A	B	C	D
MOLD NO.	26	37	44	
COMPACTOR AIR PRES.-PSI	350	350	350	
INITIAL MOIST.-%	—	—	—	
WATER ADDED-ML	90	90	70	
WATER ADDED-%	—	—	—	
MOIST AT COMPACTION %	6.7	7.5	5.8	
WET WEIGHT OF PAT-GMS	1071	1078	1009	
HEIGHT OF PAT-INCHES	2.49	2.45	2.46	
DENSITY-LB. PER CU. FT.	[illegible]	[illegible]	[illegible]	
STAB. Ph AT 1000 LBS	9	12	7	
2000 LBS.	21	23	18	
DISPLACEMENT	4.20	4.14	4.10	
"R" VALUE	80	78	83	
EXUDATION PRESS. PSI	350	200	600	

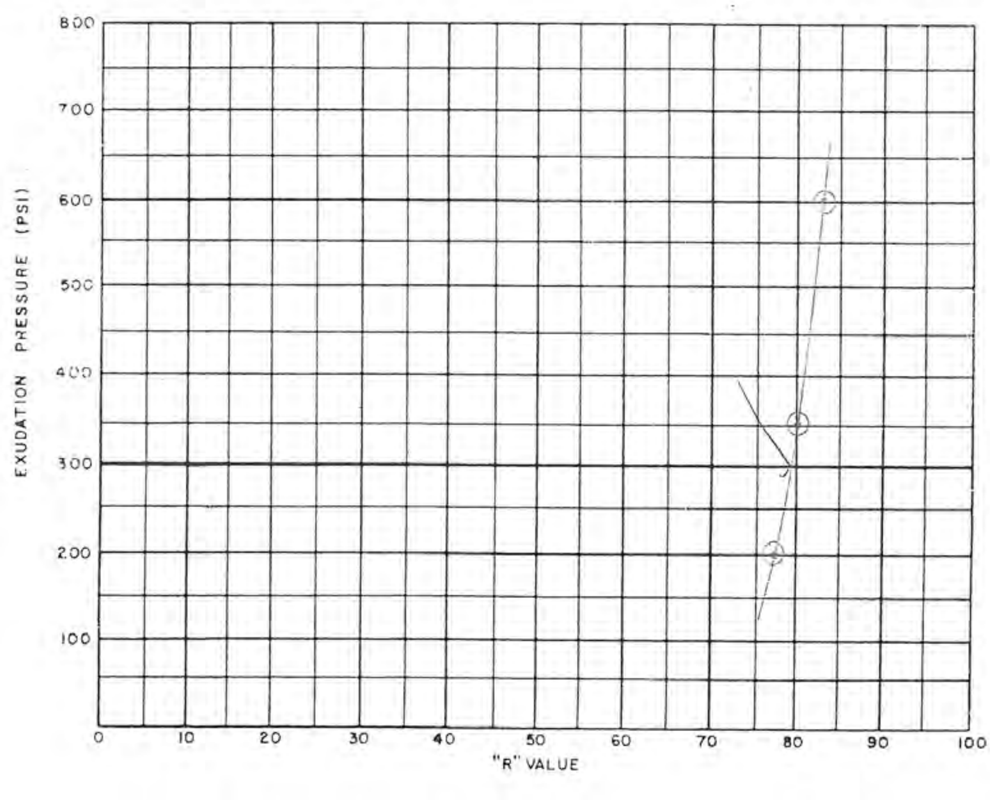
LL	PL	PI	LAB. NO
			08-258

SOIL CLASS & GROUP INDEX	PROJECT

FIELD IDENT.				STATION
INITIAL MOISTURE				1"
WET		DRY		3/4"
DRY		TARE		3/8"
WT. WATER		WT. DRY		NO. 4

EXPANSION SPECIMEN	A	B	C	D
DIAL READING				
COVER REQUIRED-INCHES				

TIN NO.	REMARKS:	T-115A
	PI - RAPVL (J, K, L)	"R" VALUE 79



WYOMING DEPARTMENT OF TRANSPORTATION
Materials Testing Laboratory
SAMPLE TRANSMITTAL

Form T-120
REVISED 8/99

☐ Metric ☒ English ☐ Preliminary ☐ Construction ☐ QC/QA

Lab # 08-26

Date Sampled 4-29-08 Date Received 5-20-08

Project Number UW RESEARCH Road Section PRY ROAD

Resident Engineer HUNTINGTON at: UW

Pit or Source ATLAS County LARAMIE

Sample Distribution

☐ Soils ☒ Aggregate ☐ Concrete ☐ Chemistry ☐ Geology

Multiple Samples 1 of 1

Sample Number(s) UW-P1-RSK S# ____ TH# ____

Location (Belt, Stockpile, etc.) ROAD SURFACE at: (Sta., kp., M.P., etc.) ____

Vertical Limits ____ to: ____

Horizontal Limits ____ to: ____

Quantity Represented ____

For Use As :

☐ Profile	☐ BSE	☐ PMP Type ____ Grd. ____	☐ Conc. Coarse Aggregate
☐ Borrow	☐ CB, Grd. ____	☐ RPMP ____	☐ Conc. Med. Aggregate
☐ Topping	☐ PMB	☐ PMWC, Type ____	☐ Conc. Fine Aggregate
☐ Alkali	☐ CTB	☐ CCA, Type ____	☐ Conc. Cylinders
☐ Check Curve	☐ Filler	☐ Maint. Type ____	☐ Conc. Beams
☐ Final Emb.	☐ Drain Gravel	☐ Check Design	☐ Port. Cement, Type ____

☒ Other SURFACING Type ____

Geosynthetics (Geogrid/Geotextile)

Product Name ____ Manufacturer ____

Remarks: ASPHALT CONTENT BY CHEMICAL EXTRACTION; SCREENED GRADATION; COHESION VALUE; R-VALUE
2466.8
1018.6
2407.8

Submitted By NB [signature]

g:\materials\shared\forms\soil & surf-120.xls Reorder # FR-6042

5

WYOMING DEPARTMENT OF TRANSPORTATION
MATERIALS LABORATORY
REPORT OF TEST ON SURFACING MATERIALS

Form T-103B
Rev. 9-06
☐ English
☐ Metric

LABORATORY NO. 2008 - 0258 DATE REC'D 4-28-08
SUBMITTED BY G. Huntington AT U.W.
I.D. MARKS ______ DATE SCREENED ______
SOURCE ______ DATE SAMPLED ______
QUANTITY REPRESENTED ______ LOCATION ______
FOR USE AS U.W Research PROJECT ______ CO. ______

TEST RESULTS

SIEVE SIZE PASSING	RET. WT. LBS.	RET. WT. GRAMS	RET %	PASSING %	RET. WT. LBS.	RET. WT. GRAMS	RET. %	PASSING %	RET. WT. LBS.	RET. WT. GRAMS	RET %	PASSING %
___ MAX		373-5										"R" Value
3" (75 mm)												
2" (50 mm)												
1 1/2 (3.75 mm)				1666.6								
1" (25 mm)	0.8		0.8	99.2								
3/4" (19 mm)	1.0		1.0	98.2								
1/2" (12.5 mm)	6.2		6.4	91.8								98
3/8" (9.50 mm)	5.1		5.3	86.5								162
#4 (4.75 mm)	22.7		23.6	62.9								444
#8 (2.36 mm)	60.2 / 100.6	75-6	12-7	50-2								1200
#16 (1.18 mm)		68-1	11-5	38-7								
#30 (600 um)		69-5	11-7	27-0								
#50 (300 um)		68-9	11-6	15-4								
#100 (150 um)		47-7	8-0	7-4								
#200 (75 um)		27-8	4-7	2-7								
PAN	15.2	15.9										
	96.4											(4)
LIQUID LIMIT	— Asphalt in Sample											
PLASTICITY INDEX	— " " "											
SAND EQUIVALENT												

Tests	Tech	Date
Screen	GJJ	5-20
LL - PI		
Wash		
Gradation	MAS	5-20
Crush		
Crush Wash		
CR LL PI		
LAR		
SE		

REMARKS UW-PI-RS (J,K,L)

EXT. CHEM. See work sheet inside
GRADE See work sheet inside
CV —— Not performed Asphalt in Sample.
"R" VALUE = 78
Inplace Moisture = 3.6% (J)
3.9% (K)
1.7% (L)

FORM T-215
REV. 4/95

WYOMING DEPARTMENT OF TRANSPORTATION
MATERIALS LABORATORY
EXTRACTION WORKSHEET

LABORATORY NO:	08-00026	DATE TESTED:	5/22/2008
ENGINEER:	HUNTINGTON	LOCATION:	LARAMIE
DATE RECEIVED:	5/19/2008	SOURCE:	ATLAS ROAD
SAMPLED ID:	UW-PL-RSK	PROJECT NO:	UW RESEARCH
FOR USE:	RAP	SOILS & SURFACING LAB NO:	

(1) WT. OF OILED SAMPLE, PAN AND FILTER:	2466.8	(4) WT. OF UNOILED SAMPLE, PAN, AND FILTER:	2407.8
(2) TARE OF PAN AND FILTER:	1018.6	(5) TARE OF PAN AND FILTER:	1018.6
(3) WT. OF OILED SAMPLE: (1 - 2)	1448.2	(6) WT. OF UNOILED SAMPLE: (4 - 5) (1387.9)	1389.2
(7) WT. OF OIL (3 - 6)	59.0	(8) % OIL: (7 / 3)*100	4.07
		THEO. OIL CONTENT:	
		WT. DRY AGG. AFTER WASH:	1254.7

NOTE: WHEN DOING A VACUUM EXTRACTION, ADD 50 GRAMS FOR FILTER AID.

	WT. RET.	% RET.	% PASSING		SPEC'S
37.5mm(1 1/2")					
25mm (1")					
19mm (3/4")					
12.6mm (1/2")	37.9	2.6	97.4		
9.5mm (3/8")	66.1	4.7	92.7		
4.75mm (#4)	255.2	18.4	74.3		
2.36mm (#8)	216.4	15.6	58.7		
1.18mm (#16)	179.4	12.9	45.8		
600µm (#30)	150.9	10.9	34.9		
300µm (#50)	136.9	9.9	25.0		
150µm (#100)	102.1	7.4	17.6		
75µm (#200)	77.8	5.6	12.0		
PAN	166.6				
31.4					
TOTAL					
	166.5	0.01			

ABSON EXTRACTION

KINEMATIC VISCOSITY:

ABSOLUTE VISCOSITY:

PENETRATION:

CHEMICAL: METHODB OVEN:

CALCULATIONS

RERUN:

REMARKS:

TESTED BY: KMM

Form T-115
Rev. 5/91

UW RESEARCH

WYOMING DEPARTMENT OF TRANSPORTATION

ATLAS ROAD

SOILS STABILOMETER WORK SHEET

TEST SPECIMEN	A	B	C	D
MOLD NO.	33	21	6A	
COMPACTOR AIR PRES.-PSI	350	350	350	
INITIAL MOIST.-%	—	—	—	
WATER ADDED-ML	80	90	70	
WATER ADDED-%	—	—	—	
MOIST AT COMPACTION %	6.7	7.5	5.8	
WET WEIGHT OF PAT-GMS	1169	1135	1141	
HEIGHT OF PAT-INCHES	2.44	2.51	2.51	
DENSITY-LB. PER CU. FT.	136.1	127.5	130.2	
STAB. Ph AT 1000 LBS	17	21	4	
2000 LBS.	22	37	19	
DISPLACEMENT	3.98	3.10	3.68	
"R" VALUE	80	73	83	
EXUDATION PRESS. PSI	400	150	[illegible]	

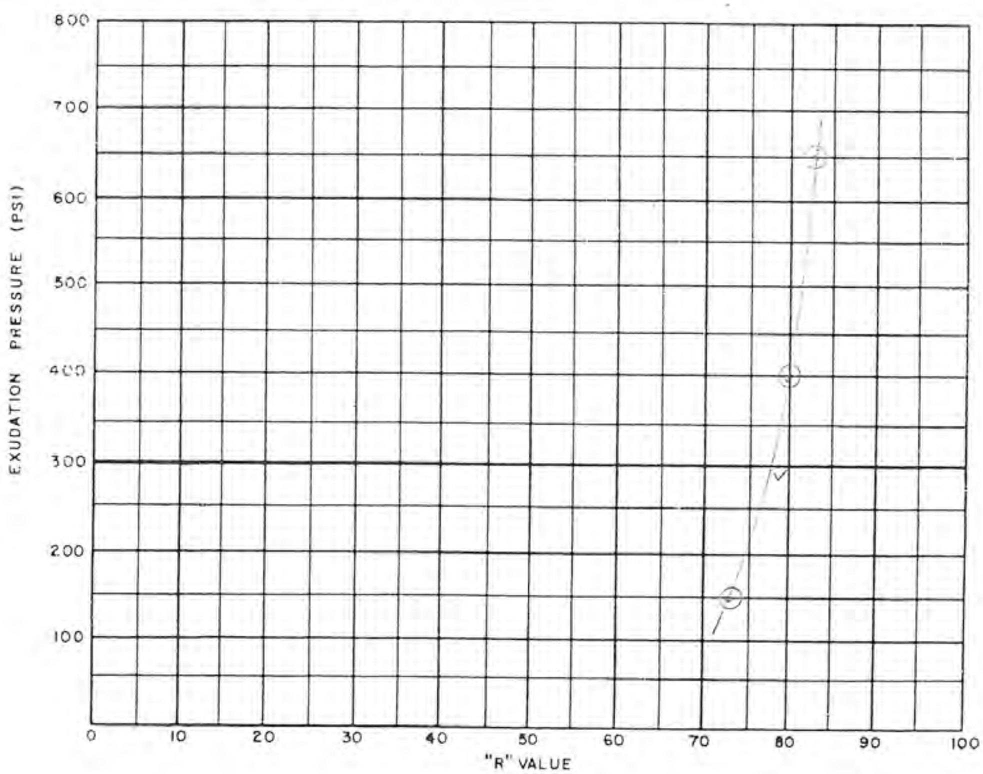
LL	PL	PI	LAB. NO
			08-258

SOIL CLASS & GROUP INDEX	PROJECT

FIELD IDENT.				STATION
INITIAL MOISTURE				1"
WET		DRY		3/4"
DRY		TARE		3/8"
WT. WATER		WT. DRY		NO. 4

EXPANSION SPECIMEN	A	B	C	D
DIAL READING				
COVER REQUIRED-INCHES				

TIN NO.	REMARKS:	T-115A
	P1-RS (J, K, L)	"R" VALUE 78



Form T-120
REVISED 8/99

WYOMING DEPARTMENT OF TRANSPORTATION

Materials Testing Laboratory

SAMPLE TRANSMITTAL

☐ Metric
☒ English

☐ Preliminary
☐ Construction

☐ QC/QA

Lab # ______

Date Sampled: 4-29-08
Date Received: [illegible]
Project Number: UW- RESEARCH
Road Section: PRY ROAD
Resident Engineer: HUNTINGTON
at: UW
Pit or Source: ATLAS PIT
County: LARAMIE

Sample Distribution

☐ Soils ☒ Aggregate ☐ Concrete ☐ Chemistry ☐ Geology

Sample Number(s): UW- PI- VWL S # ______ TH # ______

Multiple Samples: 1 of 1

Location (Belt, Stockpile, etc.): WINDROW at: (Sta., kp., M.P., etc.) ______

Vertical Limits ______ to: ______

Horizontal Limits ______ to: ______

Quantity Represented ______

For Use As:

☐ Profile	☐ BSE	☐ PMP Type ____ Grd. ____	☐ Conc. Coarse Aggregate
☐ Borrow	☐ CB, Grd. ____	☐ RPMP ____	☐ Conc. Med. Aggregate
☐ Topping	☐ PMB	☐ PMWC, Type ____	☐ Conc. Fine Aggregate
☐ Alkali	☐ CTB	☐ CCA, Type ____	☐ Conc. Cylinders
☐ Check Curve	☐ Filler	☐ Maint. Type ____	☐ Conc. Beams
☐ Final Emb.	☐ Drain Gravel	☐ Check Design	☐ Port. Cement, Type ____
☒ Other SURFACING			Type ____

Geosynthetics (Geogrid/Geotextile)

Product Name ______ Manufacturer ______

Remarks: WASH GRADATION; PL; LL; COHESION VALUE
R-VALUE; FRACTURED FACES; HYDROMETER (GEOLOGY)

Submitted By: M B Evans

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Reorder # FR 6042

WYOMING DEPARTMENT OF TRANSPORTATION
MATERIALS LABORATORY
REPORT OF TEST ON SURFACING MATERIALS

Form T-103B
Rev. 9-06
☐ English
☐ Metric

LABORATORY NO. 2008 - 0258 DATE REC'D 4-28-08
SUBMITTED BY G. Huntington AT U.W.
I.D. MARKS ______ DATE SCREENED ______
SOURCE ______ DATE SAMPLED ______
QUANTITY REPRESENTED ______ LOCATION ______
FOR USE AS U.W Research PROJECT ______ CO. ______

TEST RESULTS

SIEVE SIZE PASSING	RET. WT. LBS.	RET. WT. GRAMS	RET %	PASSING %	RET. WT. LBS.	RET. WT. GRAMS	RET. %	PASSING %	RET. WT. LBS.	RET. WT. GRAMS	RET %	PASSING %
___ MAX		360.9 270.6										"R" Value
3" (75 mm)												
2" (50 mm)												
1 1/2 (3.75 mm)				100.0								
1" (25 mm)	0.5		0.5	99.5								
3/4" (19 mm)	Ø.7		0.6	98.9								
1/2" (12.5 mm)	1.6		1.5	97.4								32
3/8" (9.50 mm)	2.3		2.1	95.3								58
#4 (4.75 mm)	85.2		78.9	16.11								1004
#8 (2.36 mm)	17.6 / 17.7	57.7	2.6	13.8								1200
#16 (1.18 mm)		51.5	2.3	11.5								
#30 (600 um)		45.6	2.1	9.4								
#50 (300 um)		41.1	1.9	7.5								
#100 (150 um)		29.2	1.3	6.2								
#200 (75 um)		34.8	1.6	4.6								
PAN	10.4	100.7 / 101.0										
	1Ø8.Ø											(4)
LIQUID LIMIT	29											
PLASTICITY INDEX	14											
SAND EQUIVALENT												

Tests	Tech	Date
Screen	CS JJ	5-15-08
LL - PI		
Wash	MAS	5-15
Gradation	MAS	5-19
Crush		
Crush Wash		
CR LL PI		
LAR		
SE		

REMARKS UW - PI - CONT (J,K,L)

WASH Grad ✓
PI ; LL: ✓
(V = 227 PSI
"R" Value = 68 (all Rock)
Fracture Faces = Insufficient Mat. to perform test.
Hydrometer = See work sheet inside.

WYOMING DEPARTMENT OF TRANSPORTATION REV. 5/96
MATERIALS TESTING LABORATORY h:\forms\soil&sur\T-DAVEG.XLS

REPORT OF NATURAL CEMENTATION OF AGGREGATE FINES

REPORT NO. ______ DATE 09/2/08
PROJECT NUMBER UW-PI VW (J,K,L) SOURCE ______
ENGINEER ______ FOR USE AS UW Research

TEST RESULTS

F + H²0 = ______
F + M + H²0 = ______
MATERIAL + TARE = ______ TARE PAN ____ g.
O.D. = ______

BULK = O.D. / (F + H²0 + 500 - F,M,H²0)

APPARENT = O.D / (F + H²0 + O.D. - F,M,H²0)

	FLASK	F + M	F + H²0
1	183.3	683.3	683.0
2	170.2	670.2	668.4
3	184.8	684.8	682.6

Moisture @ S.S.E.
MOISTURE SAMPLE FROM -4 S/G

TARE WEIGHT ______
WET WEIGHT ______ WT. OF MOISTURE ______
- DRY WEIGHT ______ ÷ DRY WEIGHT ______
= WT. OF MOISTURE ______ MOISTURE % @ S.S.D. ______

MOISTURE @ S.S.D + 5% FOR COMPACTION

MOISTURE @ COMPACTION
MOISTURE SAMPLE FROM EXCESS MATERIAL AFTER COMPACTION

TARE WEIGHT ______
WET WEIGHT 676.1 WT. OF MOISTURE 52.6
- DRY WEIGHT 623.5 ÷ DRY WEIGHT 623.5
= WT. OF MOISTURE 52.6 MOIST. % @ COMPACTION 8.4

	MACHINE LOAD				PSI
1	1125	÷	4	=	281
2	985	÷	4	=	246
3	610	÷	4	=	153
AVG.	907			AVG.	227 PSI

MOLD
OILED [X]
UNOILED [ ]

APPARENT S/G	2.599	BULK S/G	2.378
MOISTURE @ S.S.D		ABSORBTION %	3.584
MOISTURE @ COMPACTION	8.4		

NOTES:30ml=2% moisture

______ TESTED BY ______ ENGINEER

GRAIN SIZE DISTRIBUTION TEST DATA

Project: U.W. Research
Project Number: Client: G. Huntington

Sample Data

Source: UW-A1-CONT-(J,K,L)
Sample No.: 80290
Elev. or Depth: Sample Length(in./cm.):
Location:
Description: Clayey sand

Mechanical Analysis Data

Initial
Dry sample and tare= 1363.28
Tare = 0.00
Dry sample weight = 1363.28
Sample split on number 10 sieve
Split sample data:
Sample and tare = 71.56 Tare = .00 Sample weight = 71.56
Cumulative weight retained tare= .00
Tare for cumulative weight retained= .00

Sieve	Cumul. Wt. retained	Percent finer
3 inch	0.00	100.0
1.5 inch	0.00	100.0
.75 inch	0.00	100.0
.375 inch	0.00	100.0
# 4	3.48	99.7
# 10	181.42	86.7
# 20	14.54	69.1
# 40	27.08	53.9
# 100	38.23	40.4
# 200	44.52	32.8

Hydrometer Analysis Data

Separation sieve is #10
Percent -#10 based upon complete sample= 86.7
Weight of hydrometer sample: 73.1
Hygroscopic moisture correction:
Moist weight & tare = 179.84
Dry weight & tare = 178.26
Tare = 104.80
Hygroscopic moisture= 2.2 %
Calculated biased weight= 82.54
Automatic temperature correction
Composite correction at 20 deg C = -6.7

Meniscus correction only= 0
Specific gravity of solids= 2.678
Specific gravity correction factor= 0.994
Hydrometer type: 152H
Effective depth L= 16.294964 - 0.164 x Rm

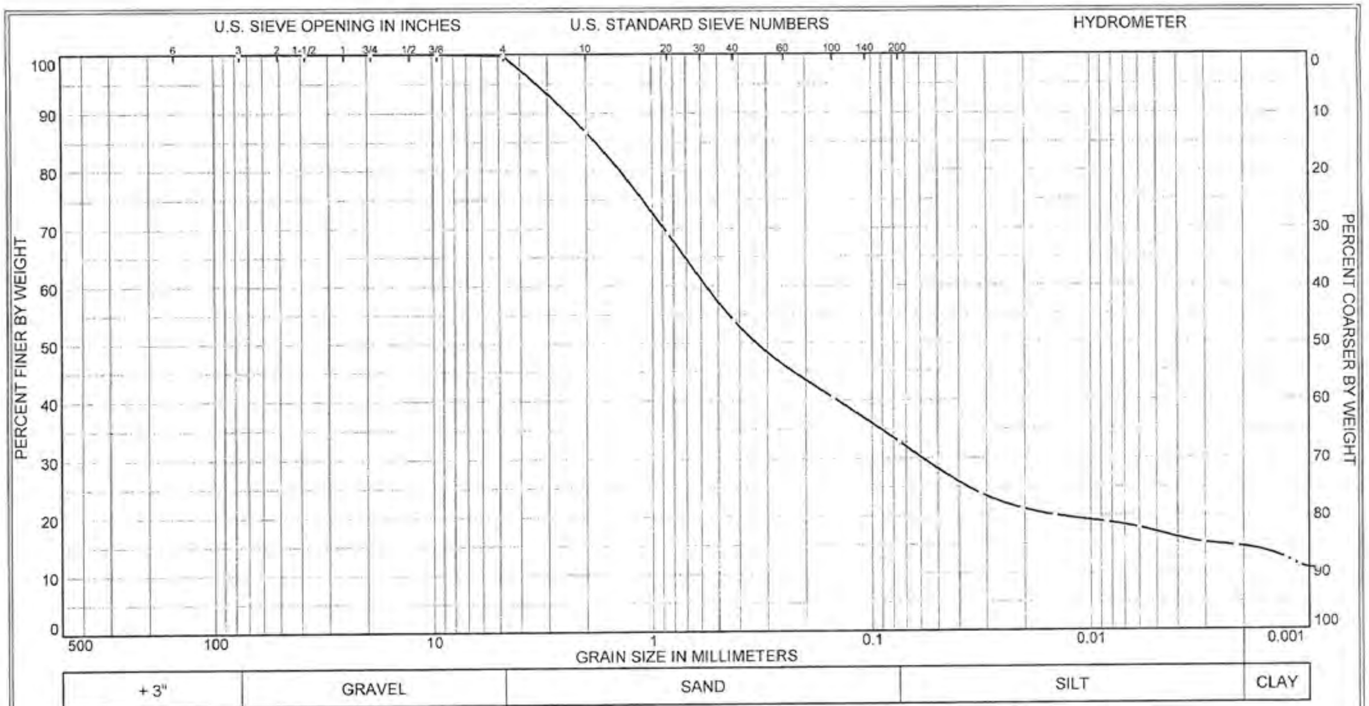
WYDOT GEOLOGY

Elapsed time, min	Temp, deg C	Actual reading	Corrected reading	K	Rm	Eff. depth	Diameter mm	Percent finer
2.00	24.0	25.5	19.8	0.0129	25.5	12.1	0.0317	23.8
5.00	23.5	23.5	17.6	0.0130	23.5	12.4	0.0205	21.2
10.00	23.5	22.5	16.6	0.0130	22.5	12.6	0.0146	20.0
30.00	23.5	21.5	15.6	0.0130	21.5	12.8	0.0085	18.8
60.00	24.0	20.5	14.8	0.0129	20.5	12.9	0.0060	17.8
240.00	23.5	18.5	12.6	0.0130	18.5	13.3	0.0030	15.2
480.00	23.5	18.0	12.1	0.0130	18.0	13.3	0.0022	14.6
1440.00	22.5	16.5	10.3	0.0131	16.5	13.6	0.0013	12.4
1680.00	22.5	16.0	9.8	0.0131	16.0	13.7	0.0012	11.8
1935.00	22.5	15.5	9.3	0.0131	15.5	13.8	0.0011	11.2
2880.00	22.5	15.0	8.8	0.0131	15.0	13.8	0.0009	10.6

Fractional Components

Gravel/Sand based on #4
Sand/Fines based on #200
% **+ 3" =** 0.0 % **GRAVEL =** 0.3 % **SAND =** 66.9
% **SILT =** 18.4 % **CLAY =** 14.4 (% **CLAY COLLOIDS =** 10.7)

D_{85}= 1.82 D_{60}= 0.57 D_{50}= 0.34
D_{30}= 0.06 D_{15}= 0.00



LOCATION	SOURCE	SAMPLE #	DEPTH/ELEV.	MATERIAL DESCRIPTION
	UW-A1-CONT-(J,K,L)	80290		Clayey sand

Project No. Client G. Huntington Report Date

Particle Size Distribution Report

U.W. Research

WYDOT GEOLOGY

Cheyenne, WY

Form T-115
Rev. 5/91

UW RESEARCH

WYOMING DEPARTMENT OF TRANSPORTATION

ATLAS ROAD

SOILS STABILOMETER WORK SHEET

TEST SPECIMEN	A	B	C	D
MOLD NO.	22	44	[illegible]	
COMPACTOR AIR PRES.-PSI	350	350	350	
INITIAL MOIST. – %	—	—	—	—
WATER ADDED – ML	100	120	140	
WATER ADDED – %	—	—	—	—
MOIST AT COMPACTION %	9.3	9.9	11.0	
WET WEIGHT OF PAT – GMS	1105	1126	1178	
HEIGHT OF PAT – INCHES	2.45	2.48	2.47	
DENSITY – LB. PER CU. FT.	126.2	124.1	129.9	
STAB. Ph AT 1000 LBS	7	9	13	
2000 LBS.	18	25	30	
DISPLACEMENT	[illegible]	[illegible]	[illegible]	
"R" VALUE	77	72	[illegible]	
EXUDATION PRESS. PSI	700	400	200	

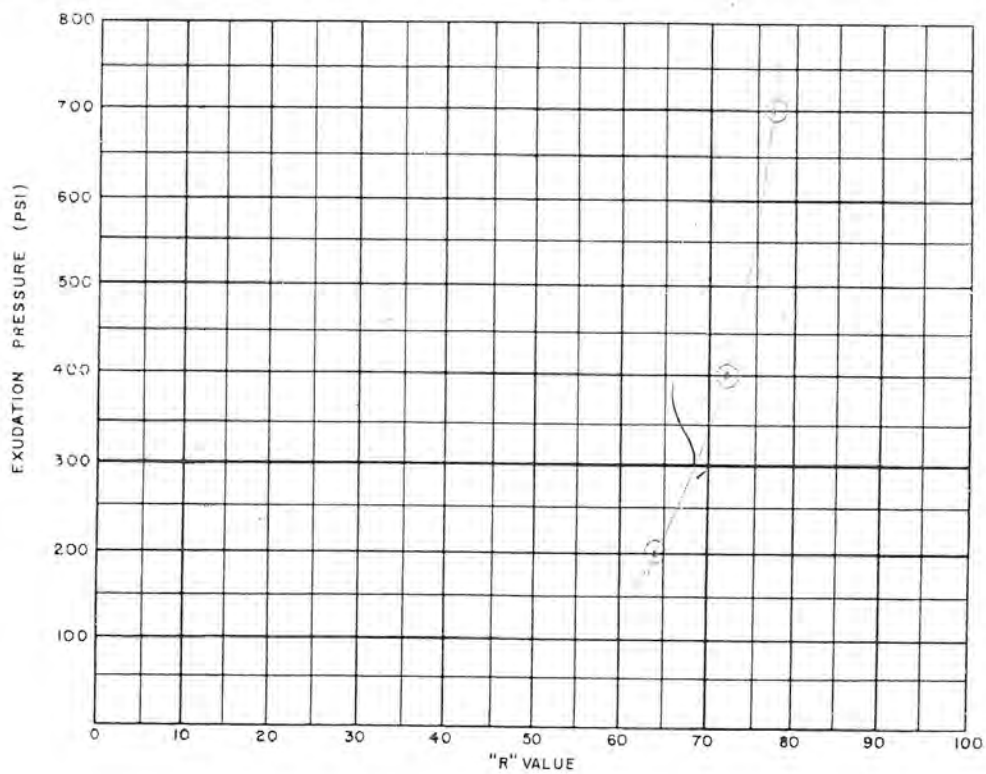
LL	PL	PI	LAB. NO
			08-258

SOIL CLASS & GROUP INDEX	PROJECT

FIELD IDENT.	STATION
INITIAL MOISTURE	1"
WET / DRY	3/4"
DRY / TARE	3/8"
WT. WATER / WT. DRY	NO. 4

EXPANSION SPECIMEN	A	B	C	D
DIAL READING	1	2	7	
COVER REQUIRED – INCHES	FD	FD	FD	

TIN NO.	REMARKS:	T-115A
	PI-CONT (J, K, L)	"R" VALUE 68



WYOMING DEPARTMENT OF TRANSPORTATION
Materials Testing Laboratory
SAMPLE TRANSMITTAL

Form T-120
REVISED 8/99

☐ Metric ☒ English ☒ Preliminary ☐ Construction ☐ QC/QA

Lab # ______

Date Sampled 7-14-08 Date Received ______

Project Number UW - RESEARCH Road Section SCHOONOVER

Resident Engineer HUNTINGTON at : UW

Pit or Source TXT Pit / I-90 County JOHNSON

Sample Distribution

☐ Soils ☒ Aggregate ☐ Concrete ☐ Chemistry ☐ Geology

Sample Number(s) UW-S-RVB-A S # ______ TH # ______ Multiple Samples 1 of 1

Location (Belt, Stockpile, etc.) STOCKPILE at: (Sta., kp., M.P., etc.) JO. CO. YARD

Vertical Limits ______ to : ______

Horizontal Limits ______ to : ______

Quantity Represented ______

For Use As :

☐ Profile ☐ BSE ☐ PMP Type ___ Grd. ___ ☐ Conc. Coarse Aggregate

☐ Borrow ☐ CB, Grd ______ ☐ RPMP ______ ☐ Conc. Med. Aggregate

☐ Topping ☐ PMB ☐ PMWC, Type ______ ☐ Conc. Fine Aggregate

☐ Alkali ☐ CTB ☐ CCA, Type ______ ☐ Conc. Cylinders

☐ Check Curve ☐ Filler ☐ Maint. Type ______ ☐ Conc. Beams

☐ Final Emb. ☐ Drain Gravel ☐ Check Design ☐ Port. Cement, Type ______

☒ Other Surfacing Type ______

Geosynthetics (Geogrid/Geotextile)

Product Name ______ **Manufacturer** ______

Remarks: Asphalt Content by chemical extraction; screened gradation; cohesion value; R-value

*

Virgin Aggregate / RAP Blend

Submitted By Scott KOCH

g:\materials\shared\forms\soil & surf\t-120.xls

Reorder # FR-6042

5

Form T-
Rev 9-C
☐ En
☐ Me

WYOMING DEPARTMENT OF TRANSPORTATION
MATERIALS LABORATORY
REPORT OF TEST ON SURFACING MATERIALS

LABORATORY NO 08 1020 DATE REC'D
SUBMITTED BY *Huntington* AT
I.D MARKS *UW-Research - VW-5-RVB-A* DATE SCREENED *10-28*
SOURCE *Cross H Pit (Stockpiled)* DATE SAMPLED *7-14*
QUANTITY REPRESENTED *1sk* LOCATION
FOR USE AS *Surfacing* PROJECT CO

TEST RESULTS

SIEVE SIZE PASSING	RET. WT. LBS.	RET. WT. GRAMS	RET %	PASSING %	RET. WT. LBS.	RET. WT. GRAMS	RET. %	PASSING %	RET. WT. LBS.	RET. WT. GRAMS	RET %	PASS %
MAX		334.9								"R" Value		
3" (75 mm)												
2" (50 mm)				100.0								
1 1/2 (3.75 mm)	6.2		0.5	99.5								
1" (25 mm)	1.0		2.5	97.0								
3/4" (19 mm)	2.1		5.2	91.5								
1/2" (12.5 mm)	6.1		15.2	76.6						280		
3/8" (9.50 mm)	3.4		8.5	68.1						382		
#4 (4.75 mm)	7.9		19.7	48.4						618		
#8 (2.36 mm)	19.1 / 19.4	36.1	12.4	36.0						1200		
#16 (1.18 mm)		87.9	12.7	23.3								
#30 (600 um)		74.7	10.8	12.5								
#50 (300 um)		53.3	7.7	4.8								
#100 (150 um)		21.1	3.0	1.8								
#200 (75 um)		7.3	1.1	0.7								
PAN	4.1	4.1 / 4.5										
	40.1									(4)		
LIQUID LIMIT	—											
PLASTICITY INDEX	—											
SAND EQUIVALENT												

Tests	Tech	Date
Screen	*Cm*	*10-28*
LL - PI		
Wash	*MAS*	*10-28*
Gradation	↓	↓
Crush		
Crush Wash		
CR LL PI		
LAR		

REMARKS *UW-S-RVB (A)*

Chem. Ext ✓
"R" Value = 78

UW Research

Form T-115
Rev. 5/91

WYOMING DEPARTMENT OF TRANSPORTATION

SOILS STABILOMETER WORK SHEET

TEST SPECIMEN	A	B	C	D
MOLD NO.	54	10A	20A	
COMPACTOR AIR PRES.-PSI	350	350	350	
INITIAL MOIST.-%	—	—	—	
WATER ADDED—ML	80	100	90	
WATER ADDED—%	—	—	—	
MOIST AT COMPACTION %	6.7	8.3	7.5	
WET WEIGHT OF PAT—GMS	1145	1190	1192	
HEIGHT OF PAT—INCHES	2.47	2.35	2.42	
DENSITY—LB.PER CU.FT.	131.6	141.7	138.8	
STAB. Ph AT 1000 LBS	7	10	9	
2000 LBS.	12	22	18	
DISPLACEMENT	5.22	5.51	5.58	
"R" VALUE	76	~~74~~ 71	78	
EXUDATION PRESS. PSI	600	150	300	

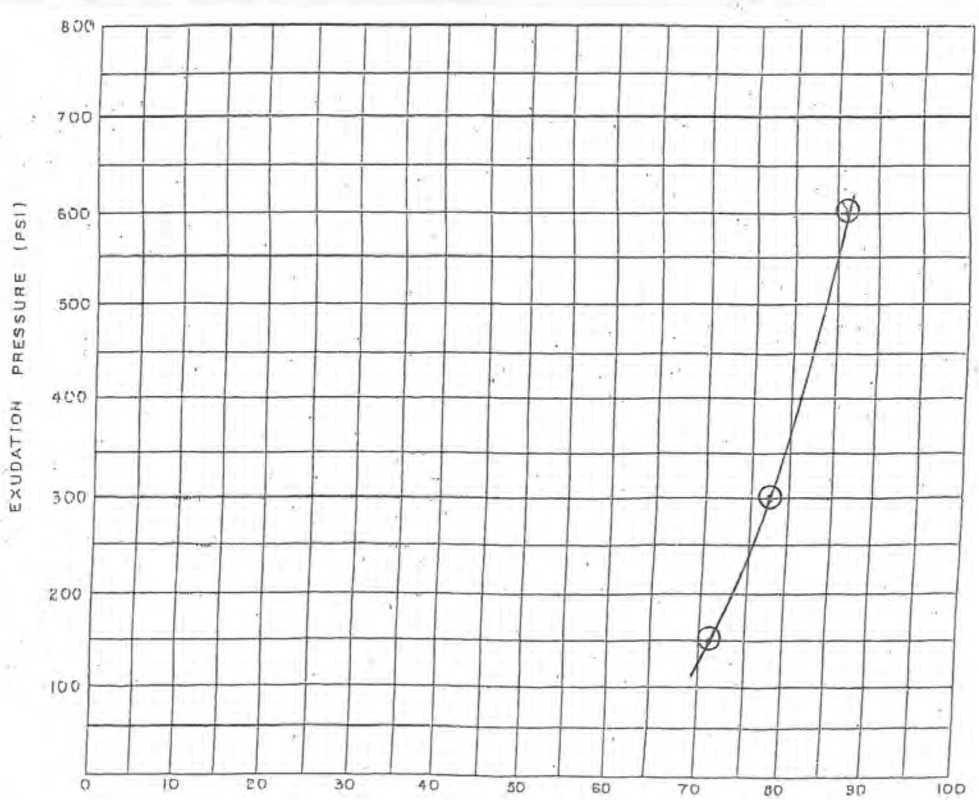
LL	PL	PI	LAB. NO.
			08-1020

SOIL CLASS & GROUP INDEX	PROJECT

FIELD IDENT				STATION
INITIAL MOISTURE				1"
WET	320.0	DRY		3/4"
DRY		TARE	80.0	3/8"
WT. WATER		WT. DRY		NO. 4

EXPANSION SPECIMEN	A	B	C	D
DIAL READING				
COVER REQUIRED — INCHES				

TIN NO.	REMARKS:	T-115A "R" VALUE
	UW-S-RUB-A	78



FORM T-215
REV. 4/95

WYOMING DEPARTMENT OF TRANSPORTATION
MATERIALS LABORATORY
EXTRACTION WORKSHEET

LABORATORY NO:	08-00170	DATE TESTED:	11/5/2008
ENGINEER:	HUNTINGTON	LOCATION:	UW
DATE RECEIVED:	11/4/2008	SOURCE:	TXT PIT I-90
SAMPLED ID:	UW-S-RVB-A	PROJECT NO:	UW-RESEARCH
FOR USE:	RAP	SOILS & SURFACING LAB NO:	08 - 1039

(1) WT. OF OILED SAMPLE, PAN AND FILTER:	2317.8	(4) WT. OF UNOILED SAMPLE, PAN, AND FILTER:	2293.8
(2) TARE OF PAN AND FILTER:	1117.6	(5) TARE OF PAN AND FILTER:	1117.6
(3) WT. OF OILED SAMPLE: (1 - 2)	1200.2	(6) WT. OF UNOILED SAMPLE: (4 - 5)	1175.5 1176.2
(7) WT. OF OIL (3 - 6)	24.0	(8) % OIL: (7 / 3)*100	2.00
		THEO. OIL CONTENT:	
		WT. DRY AGG. AFTER WASH:	

NOTE: WHEN DOING A VACUUM EXTRACTION, ADD 50 GRAMS FOR FILTER AID:

	WT. RET.	% RET.	% PASSING		SPEC'S
37.5mm(1 1/2")					
25mm (1")					
19mm (3/4")			100.0		
12.6mm (1/2")	192.0	16.3	83.7		
9.5mm (3/8")	95.2	8.1	75.6		
4.75mm (#4)	219.6	18.7	56.9		
2.36mm (#8)	119.5	10.2	46.7		
1.18mm (#16)	141.4	12.0	34.7		
600µm (#30)	119.2	10.1	24.6		
300µm (#50)	96.5	8.2	16.4		
150µm (#100)	71.5	6.1	10.3		
75µm (#200)	36.5	3.1	7.2		
PAN	82.5 / 64.1				
TOTAL					

ABSON EXTRACTION

KINEMATIC VISCOSITY:

ABSOLUTE VISCOSITY:

PENETRATION:

CHEMICAL: METHODB OVEN:

CALCULATIONS

RERUN:

REMARKS:

TESTED BY: KMM

WYOMING DEPARTMENT OF TRANSPORTATION

Materials Testing Laboratory

SAMPLE TRANSMITTAL

Form T-120 REVISED 8/99

☐ Metric ☒ English

☒ Preliminary ☐ Construction ☐ QC/QA

Lab # 08-170

Date Sampled 7-14-08 Date Received 11-4-08

Project Number UW - RESEARCH Road Section SCHOONOVER

Resident Engineer HUNTINGTON at : UW

Pit or Source TXT Pit / I-90 County JOHNSON

Sample Distribution

☐ Soils ☒ Aggregate ☐ Concrete ☐ Chemistry ☐ Geology

Sample Number(s) UW-S-RVB-A S # ______ TH # ______ Multiple Samples 1 of 1

Location (Belt, Stockpile, etc.) STOCKPILE at: (Sta., kp., M.P., etc.) JO. CO. YARD

Vertical Limits ______ to : ______

Horizontal Limits ______ to : ______

Quantity Represented ______

For Use As :

☐ Profile	☐ BSE	☐ PMP, Type ____ Grd. ____	☐ Conc. Coarse Aggregate
☐ Borrow	☐ CB, Grd ____	☐ RPMP ____	☐ Conc. Med. Aggregate
☐ Topping	☐ PMB	☐ PMWC, Type ____	☐ Conc. Fine Aggregate
☐ Alkali	☐ CTB	☐ CCA, Type ____	☐ Conc. Cylinders
☐ Check Curve	☐ Filler	☐ Maint. Type ____	☐ Conc. Beams
☐ Final Emb.	☐ Drain Gravel	☐ Check Design	☐ Port. Cement, Type ____
☒ Other Surfacing			Type ____

Geosynthetics (Geogrid/Geotextile)

Product Name ______ Manufacturer ______

Remarks: Asphalt Content by chemical extraction; Screened gradation; cohesion value; R-value

1 2317.8

1117.6

Virgin Aggregate / RAP Blend 2293.8

Submitted By Scott KOCH

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WYOMING DEPARTMENT OF TRANSPORTATION
Materials Testing Laboratory
SAMPLE TRANSMITTAL

Form T-120
REVISED 8/99

☐ Metric ☒ English ☒ Preliminary ☐ Construction ☐ QC/QA

Lab # ____

Date Sampled: 7-14-08 Date Received: ____

Project Number: UW - RESEARCH Road Section: SCHOONOVER

Resident Engineer: HUNTINGTON at: UW

Pit or Source: T x T Pit / I-90 County: JOHNSON

Sample Distribution

☐ Soils ☒ Aggregate ☐ Concrete ☐ Chemistry ☐ Geology

Multiple Samples: 1 of 1

Sample Number(s): UW - S - RVB - B S # ____ TH # ____

Location (Belt, Stockpile, etc.): STOCKPILE at: (Sta., kp., M.P., etc.) ____

Vertical Limits ____ to: ____

Horizontal Limits ____ to: ____

Quantity Represented ____

For Use As :

☐ Profile	☐ BSE	☐ PMP, Type ____ Grd. ____	☐ Conc. Coarse Aggregate
☐ Borrow	☐ CB, Grd. ____	☐ RPMP ____	☐ Conc. Med. Aggregate
☐ Topping	☐ PMB	☐ PMWC, Type ____	☐ Conc. Fine Aggregate
☐ Alkali	☐ CTB	☐ CCA, Type ____	☐ Conc. Cylinders
☐ Check Curve	☐ Filler	☐ Maint. Type ____	☐ Conc. Beams
☐ Final Emb.	☐ Drain Gravel	☐ Check Design	☐ Port. Cement, Type ____
☒ Other: SURFACING			Type ____

Geosynthetics (Geogrid/Geotextile)

Product Name ____ Manufacturer ____

Remarks: ASPHALT CONTENT BY CHEMICAL EXTRACTION
SCREENED GRADATION ; COHESION VALUE ; R-VALUE

*
VIRGIN AGGREGATE / RAP BLEND

Submitted By: Scott Koch

g:\materials\shared\forms\soil & sum\t-120.xls Reorder # FR-6042

WYOMING DEPARTMENT OF TRANSPORTATION
MATERIALS LABORATORY
REPORT OF TEST ON SURFACING MATERIALS

Form T-
Rev 8-C
☐ En
☐ Me

LABORATORY NO. 08 1020 DATE REC'D ______
SUBMITTED BY *Huntington* AT ______
I.D. MARKS *UW-Research - UW-S-RVB-B* DATE SCREENED *10-28*
SOURCE *Cross H Pit (Stockpiled)* DATE SAMPLED *7-14*
QUANTITY REPRESENTED *1sk* LOCATION ______
FOR USE AS *Surfacing* PROJECT ______ CO ______

TEST RESULTS

SIEVE SIZE PASSING	RET. WT. LBS.	RET. WT. GRAMS	RET %	PASSING %	RET. WT. LBS.	RET. WT. GRAMS	RET %	PASSING %	RET. WT. LBS.	RET. WT. GRAMS	RET %	PASS %
MAX		422.9								"R" Value		
3" (75 mm)												
2" (50 mm)												
1 1/2 (3.75 mm)				100.0								
1" (25 mm)	0.5		1.5	98.5								
3/4" (19 mm)	1.4		4.1	94.4								
1/2" (12.5 mm)	4.8		14.2	80.2						238		
3/8" (9.50 mm)	2.9		8.6	71.6						342		
#4 (4.75 mm)	7.7		22.7	48.9						614		
#8 (2.36 mm)	16.3 / 16.6	178.7	20.7	28.2						1200		
#16 (1.18 mm)		122.9	14.2	14.0								
#30 (600 um)		62.4	7.2	6.8								
#50 (300 um)		28.9	3.3	3.5								
#100 (150 um)		13.5	1.6	1.9								
#200 (75 um)		3.3	0.4	1.5								
PAN	12.7	13.2										
	33.9									(4)		
LIQUID LIMIT	—											
PLASTICITY INDEX	—											
SAND EQUIVALENT												

Tests	Tech	Date
Screen	*Cm*	*10-28*
LL - PI		
Wash		
Gradation		
Crush		
Crush Wash		
CR LL PI		
LAR		

REMARKS *UW-S-RVB-(B)*

Chem. Ext. ✓
"R" Value = 79

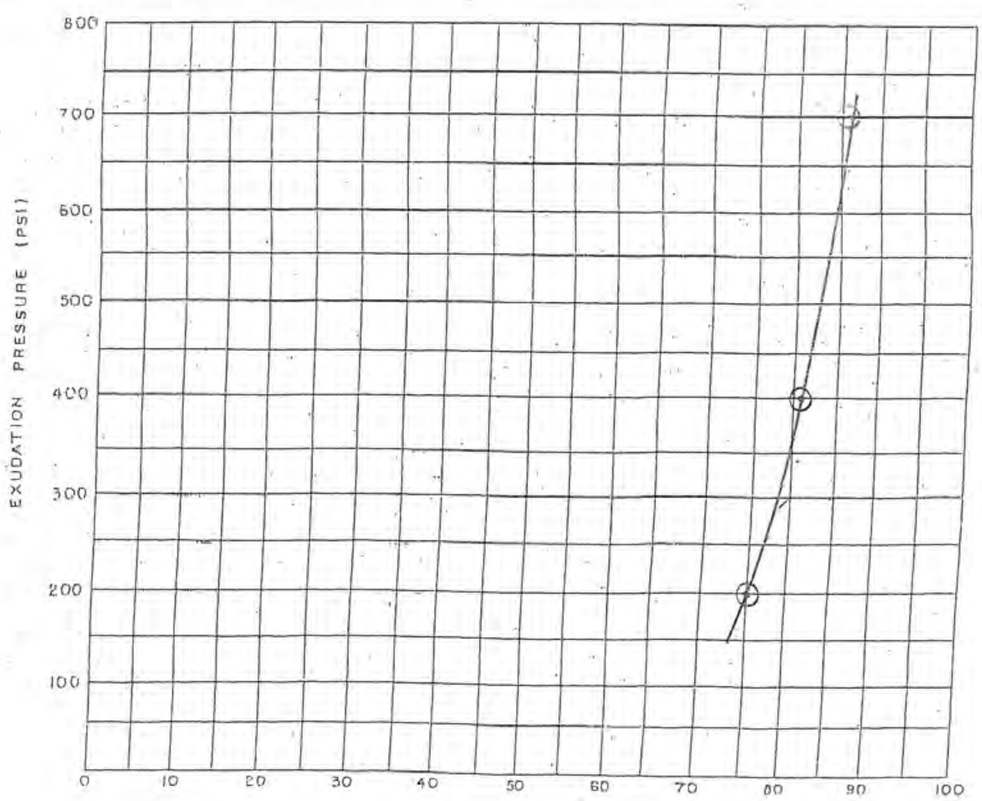
UW Research

Form T-115
Rev. 5/91

WYOMING DEPARTMENT OF TRANSPORTATION

SOILS STABILOMETER WORK SHEET

TEST SPECIMEN	A	B	C	D	LL	PL	PI	LAB. NO.			
MOLD NO.	1A	12A	3A					08 1020			
COMPACTOR AIR PRES.-PSI	350	350	350		SOIL CLASS & GROUP INDEX				PROJECT		
INITIAL MOIST. - %											
WATER ADDED—ML	80	60	70		FIELD IDENT.				STATION		
WATER ADDED—%					INITIAL MOISTURE				1"		
MOIST AT COMPACTION %	6.7	4.9	5.8		WET	320.0	DRY		3/4"		
WET WEIGHT OF PAT—GMS	1162	1153	1177		DRY		TARE	80.0	3/8"		
HEIGHT OF PAT—INCHES	2.46	2.48	2.47		WT. WATER		WT. DRY		NO. 4		
DENSITY—LB.PER CU.FT.	137.5	134.3	136.5		EXPANSION SPECIMEN				A	B	C	D
STAB. Ph AT 1000 LBS	11	7	9		DIAL READING						
2000 LBS.	23	12	17		COVER REQUIRED — INCHES						
DISPLACEMENT	4.93	5.17	5.04		TIN NO.	REMARKS:				T-115A	
"R" VALUE	75	86	81			UW-5-RUB-B				"R" VALUE 79	
EXUDATION PRESS. PSI	200	700	400								



FORM T-215
REV. 4/95

WYOMING DEPARTMENT OF TRANSPORTATION
MATERIALS LABORATORY
EXTRACTION WORKSHEET

LABORATORY NO:	08-00171	DATE TESTED:	11/5/2008
ENGINEER:	HUNTINGTON	LOCATION:	UW
DATE RECEIVED:	11/4/2008	SOURCE:	TXT PIT I-90
SAMPLED ID:	UW-S-RVB-B	PROJECT NO:	UW-RESEARCH
FOR USE:	RAP	SOILS & SURFACING LAB NO:	08 - 1040

(1) WT. OF OILED SAMPLE, PAN AND FILTER:	2314.8	(4) WT. OF UNOILED SAMPLE, PAN, AND FILTER:	2286
(2) TARE OF PAN AND FILTER:	1114.4	(5) TARE OF PAN AND FILTER:	1114.4
(3) WT. OF OILED SAMPLE: (1 - 2)	1200.4	(6) WT. OF UNOILED SAMPLE: (4 - 5)	1170.7 1171.6
(7) WT. OF OIL (3 - 6)	28.8	(8) % OIL: (7 / 3)*100	2.40
		THEO. OIL CONTENT:	
		WT. DRY AGG. AFTER WASH:	

NOTE: WHEN DOING A VACUUM EXTRACTION, ADD 50 GRAMS FOR FILTER AID.

	WT. RET.	% RET.	% PASSING		SPEC'S
37.5mm(1 1/2")					
25mm (1")			100.0		
19mm (3/4")	20.0	1.8	[illegible]		
12.6mm (1/2")	[illegible]	[illegible]	[illegible]		
9.5mm (3/8")	86.0	7.3	73.3		
4.75mm (#4)	203.8	17.4	55.9		
2.36mm (#8)	93.2	8.0	47.9		
1.18mm (#16)	110.5	9.4	38.5		
600µm (#30)	110.9	9.5	29.0		
300µm (#50)	116.5	10.0	19.0		
150µm (#100)	84.5	7.2	11.8		
75µm (#200)	53.9	4.6	7.2		
PAN 19.1	53.6 / 84.8	0.1			
TOTAL					

ABSON EXTRACTION

KINEMATIC VISCOSITY: ______

ABSOLUTE VISCOSITY: ______

PENETRATION: ______

CHEMICAL: METHODB OVEN: ______

CALCULATIONS

RERUN:

REMARKS:

TESTED BY: KMM

WYOMING DEPARTMENT OF TRANSPORTATION

Materials Testing Laboratory

SAMPLE TRANSMITTAL

Form T-120 REVISED 8/99

☐ Metric ☒ English ☒ Preliminary ☐ Construction ☐ QC/QA

Lab # 08-171

Date Sampled 7-14-08 Date Received 11-4-08

Project Number UW - RESEARCH Road Section SCHOONOVER

Resident Engineer HUNTINGTON at: UW

Pit or Source T x T PIT / I-90 County JOHNSON

Sample Distribution

☐ Soils ☒ Aggregate ☐ Concrete ☐ Chemistry ☐ Geology

Sample Number(s) UW - S - RVB - B S # ____ TH # ____ Multiple Samples 1 of 1

Location (Belt, Stockpile, etc.) STOCKPILE at: (Sta., kp., M.P., etc.) ____

Vertical Limits ____ to: ____

Horizontal Limits ____ to: ____

Quantity Represented ____

For Use As:

☐ Profile	☐ BSE	☐ PMP, Type ____ Grd. ____	☐ Conc. Coarse Aggregate
☐ Borrow	☐ CB, Grd. ____	☐ RPMP ____	☐ Conc. Med. Aggregate
☐ Topping	☐ PMB	☐ PMWC, Type ____	☐ Conc. Fine Aggregate
☐ Alkali	☐ CTB	☐ CCA, Type ____	☐ Conc. Cylinders
☐ Check Curve	☐ Filler	☐ Maint. Type ____	☐ Conc. Beams
☐ Final Emb.	☐ Drain Gravel	☐ Check Design	☐ Port. Cement, Type ____
☒ Other SURFACING			Type ____

Geosynthetics (Geogrid/Geotextile)

Product Name ____ Manufacturer ____

Remarks: ASPHALT CONTENT BY CHEMICAL EXTRACTION
SCREENED GRADATION ; COHESION VALUE ; R-VALUE
2314.8
1114.4
VIRGIN AGGREGATE / RAP BLEND 2286.0

Submitted By Scott Koch

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WYOMING DEPARTMENT OF TRANSPORTATION
Materials Testing Laboratory
SAMPLE TRANSMITTAL

Form T-120
REVISED 8/99

☐ Metric
☒ English

☒ Preliminary
☐ Construction

☐ QC/QA

Lab # ____

Date Sampled: 7-14-08
Date Received: ____
Project Number: UW-RESEARCH
Road Section: SCHOONOVER
Resident Engineer: HUNTINGTON
at: UW
Pit or Source: T*T PIT / I-90
County: JOHNSON

Sample Distribution

☐ Soils ☐ Aggregate ☐ Concrete ☐ Chemistry ☐ Geology

Sample Number(s): UW-S-RUB-C S# ____ TH# ____

Multiple Samples: 1 of 1

Location (Belt, Stockpile, etc.): STOCKPILE at: (Sta., kp., M.P., etc.) ____

Vertical Limits ____ to: ____

Horizontal Limits ____ to: ____

Quantity Represented ____

For Use As :

☐ Profile ☐ BSE ☐ PMP, Type ____ Grd. ____ ☐ Conc. Coarse Aggregate

☐ Borrow ☐ CB, Grd. ____ ☐ RPMP ____ ☐ Conc. Med. Aggregate

☐ Topping ☐ PMB ☐ PMWC, Type ____ ☐ Conc. Fine Aggregate

☐ Alkali ☐ CTB ☐ CCA, Type ____ ☐ Conc. Cylinders

☐ Check Curve ☐ Filler ☐ Maint. Type ____ ☐ Conc. Beams

☐ Final Emb. ☐ Drain Gravel ☐ Check Design ☐ Port. Cement, Type ____

☒ Other SURFACING Type ____

Geosynthetics (Geogrid/Geotextile)

Product Name ____ Manufacturer ____

Remarks: ASPHALT CONTENT BY CHEMICAL EXTRACTION
SCREENED GRADATION; COHESION VALUE; R-VALUE

*
VIRGIN AGGREGATE / RAP BLEND

Submitted By: Scott Koch

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Reorder # FR-6042

5

WYOMING DEPARTMENT OF TRANSPORTATION
MATERIALS LABORATORY
REPORT OF TEST ON SURFACING MATERIALS

Form T-
Rev 6-C
☐ En
☐ Me

LABORATORY NO 08 1020 DATE REC'D

SUBMITTED BY Huntington AT

I.D MARKS UW-Research - UW-S-RVB-C DATE SCREENED 10-28

SOURCE Cross H Pit (Stockpiled) DATE SAMPLED 7-14

QUANTITY REPRESENTED 15k LOCATION

FOR USE AS Surfacing PROJECT CO

TEST RESULTS

SIEVE SIZE PASSING	RET. WT. LBS.	RET. WT. GRAMS	RET %	PASSING %	RET. WT. LBS.	RET. WT. GRAMS	RET %	PASSING %	RET. WT. LBS.	RET. WT. GRAMS	RET %	PASS %
MAX		351.2								R Value		
3" (75 mm)												
2" (50 mm)				100.0								
1 1/2 (3.75 mm)	0.2		0.6	99.4								
1" (25 mm)	1.0		2.9	96.5								
3/4" (19 mm)	2.0		5.7	90.8								
1/2" (12.5 mm)	5.6		16.1	74.7						304		
3/8" (9.50 mm)	3.0		8.6	66.1						408		
#4 (4.75 mm)	6.5		18.7	47.4						632		
#8 (2.36 mm)	16.3 / 16.5	105.8	14.3	33.1						1200		
#16 (1.18 mm)		90.4	12.2	20.9								
#30 (600 um)		73.1	9.9	11.0								
#50 (300 um)		48.4	6.5	4.5								
#100 (150 um)		20.2	2.7	1.8								
#200 (75 um)		7.6	1.0	0.8								
PAN	5.4	5.7										
	34.8									(4)		
LIQUID LIMIT	—											
PLASTICITY INDEX	—											
SAND EQUIVALENT												

Tests	Tech	Date
Screen	Cm	10-28
LL - PI		
Wash	MAS	10-28
Gradation	|	|
Crush		
Crush Wash		
CR LL PI		
LAR		

REMARKS UW-S-RVB (C)

Chem. Ext. ✓

"R" Value = 80

UW Research

Form T-115
Rev. 5/91

WYOMING DEPARTMENT OF TRANSPORTATION

SOILS STABILOMETER WORK SHEET

TEST SPECIMEN	A	B	C	D
MOLD NO.	6M	11M	15M	
COMPACTOR AIR PRES.-PSI	350	350	350	
INITIAL MOIST.-%				
WATER ADDED-ML	80	60	70	
WATER ADDED-%				
MOIST AT COMPACTION %	6.7	4.9	5.8	
WET WEIGHT OF PAT-GMS	1189	1130	1178	
HEIGHT OF PAT-INCHES	2.42	2.53	2.45	
DENSITY-LB.PER CU.FT.	139.5	139.0	137.7	
STAB. Ph AT 1000 LBS	9	7	8	
2000 LBS.	18	13	15	
DISPLACEMENT	5.49	5.27	5.33	
"R" VALUE	72	84	82	
EXUDATION PRESS. PSI	200	700	400	

LL	PL	PI	LAB. NO.
			08 1020

SOIL CLASS & GROUP INDEX | PROJECT

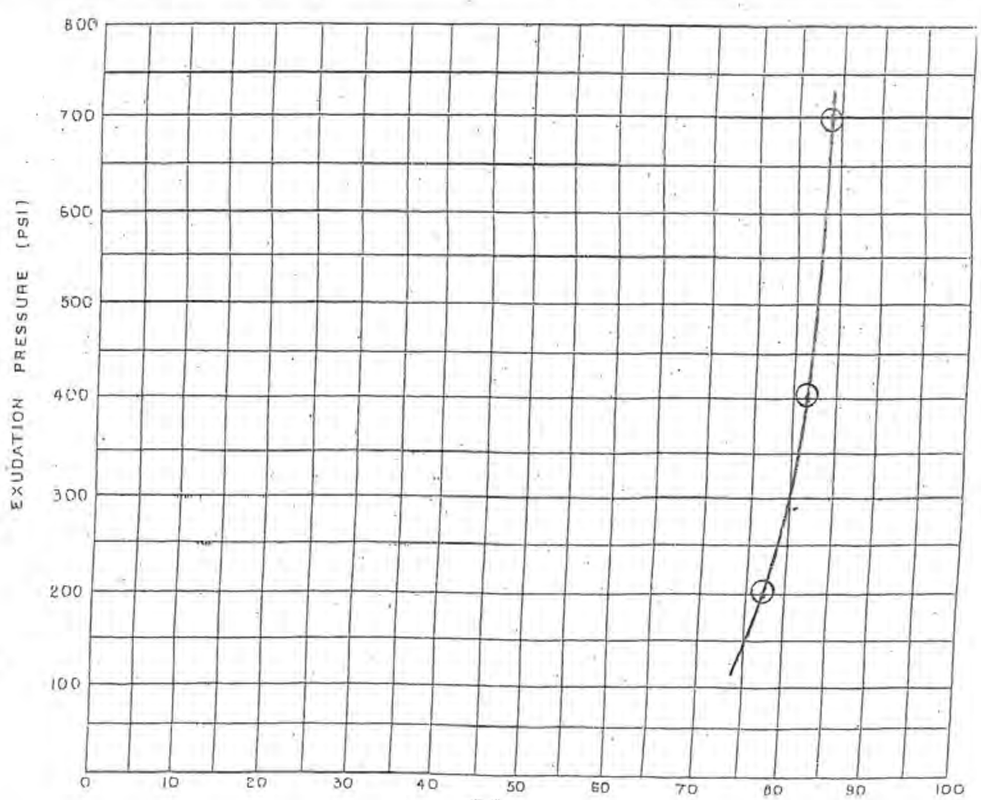
FIELD IDENT. | STATION

INITIAL MOISTURE				
WET	320.0	DRY		1"
DRY		TARE	80.0	3/4"
WT. WATER		WT. DRY		3/8"
				NO. 4

EXPANSION SPECIMEN	A	B	C	D
DIAL READING				
COVER REQUIRED—INCHES				

TIN NO. | REMARKS: UW-S-RUB-E | T-115A

"R" VALUE 80



FORM T-215
REV. 4/95

WYOMING DEPARTMENT OF TRANSPORTATION
MATERIALS LABORATORY
EXTRACTION WORKSHEET

LABORATORY NO:	08-00172	DATE TESTED:	11/5/2008
ENGINEER:	HUNTINGTON	LOCATION:	UW
DATE RECEIVED:	11/4/2008	SOURCE:	TXT PIT I-90
SAMPLED ID:	UW-S-RVB-C	PROJECT NO:	UW-RESEARCH
FOR USE:	RAP	SOILS & SURFACING LAB NO:	08 - 1041

(1) WT. OF OILED SAMPLE, PAN AND FILTER:	2277.6	(4) WT. OF UNOILED SAMPLE, PAN, AND FILTER:	2251.8
(2) TARE OF PAN AND FILTER:	1077.4	(5) TARE OF PAN AND FILTER:	1077.4
(3) WT. OF OILED SAMPLE: (1 - 2)	1200.2	(6) WT. OF UNOILED SAMPLE: (4 - 5)	1173.5 1174.4
(7) WT. OF OIL (3 - 6)	25.8	(8) % OIL: (7 / 3)*100	2.15
		THEO. OIL CONTENT:	
NOTE: WHEN DOING A VACUUM EXTRACTION, ADD 50 GRAMS FOR FILTER AID.		WT. DRY AGG. AFTER WASH:	1124.9

	WT. RET.	% RET.	% PASSING		SPEC'S
37.5mm(1 1/2")					
25mm (1")			[illegible]		
19mm (3/4")	32.6	2.7	97.3		
12.5mm (1/2")	217.8	19.4	78.0		
9.5mm (3/8")	113.2	9.7	67.6		
4.75mm (#4)	152.3	15.7	53.3		
2.36mm (#8)	95.0	8.1	45.2		
1.18mm (#16)	111.1	9.7	35.5		
600µm (#30)	116.2	9.9	25.6		
300µm (#50)	107.7	9.2	16.4		
150µm (#100)	78.5	6.6	9.8		
75µm (#200)	48.6	4.1	5.7		
PAN 17.3	65.9 / 67.1	6.1			
TOTAL					

ABSON EXTRACTION

KINEMATIC VISCOSITY:

ABSOLUTE VISCOSITY:

PENETRATION:

CHEMICAL: METHODB OVEN:

CALCULATIONS

RERUN:

REMARKS:

TESTED BY: KMM

WYOMING DEPARTMENT OF TRANSPORTATION
Materials Testing Laboratory
SAMPLE TRANSMITTAL

Form T-120
REVISED 8/99

☐ Metric
☒ English

☒ Preliminary
☐ Construction
☐ QC/QA

Lab # 08-172

Date Sampled 7-14-08 Date Received 11-4-08

Project Number UW-RESEARCH Road Section SCHOONOVER

Resident Engineer HUNTINGTON at: UW

Pit or Source TxT PIT / I-90 County JOHNSON

Sample Distribution

☐ Soils ☐ Aggregate ☐ Concrete ☐ Chemistry ☐ Geology

Multiple Samples 1 of 1

Sample Number(s) UW-S-RUB-C S # ____ TH # ____

Location (Belt, Stockpile, etc.) STOCKPILE at: (Sta., kp., M.P., etc.) ____

Vertical Limits ____ to: ____

Horizontal Limits ____ to: ____

Quantity Represented ____

For Use As :

☐ Profile	☐ BSE	☐ PMP, Type ____ Grd. ____	☐ Conc. Coarse Aggregate
☐ Borrow	☐ CB, Grd. ____	☐ RPMP ____	☐ Conc. Med. Aggregate
☐ Topping	☐ PMB	☐ PMWC, Type ____	☐ Conc. Fine Aggregate
☐ Alkali	☐ CTB	☐ CCA, Type ____	☐ Conc. Cylinders
☐ Check Curve	☐ Filler	☐ Maint. Type ____	☐ Conc. Beams
☐ Final Emb.	☐ Drain Gravel	☐ Check Design	☐ Port. Cement, Type ____
☒ Other SURFACING			Type ____

Geosynthetics (Geogrid/Geotextile)

Product Name ____ Manufacturer ____

Remarks: ASPHALT CONTENT BY CHEMICAL EXTRACTION
SCREENED GRADATION; COHESION VALUE; R-VALUE
22776
10774
VIRGIN AGGREGATE / RAP BLEND 2251.8

Submitted By Scott Koch

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WYOMING DEPARTMENT OF TRANSPORTATION

Materials Testing Laboratory

SAMPLE TRANSMITTAL

Form T-120 REVISED 8/99

☐ Metric ☒ English

☒ Preliminary ☐ Construction

☐ QC/QA

Lab # ______

Date Sampled 7.14.08 Date Received ______

Project Number 1W-Research Road Section Schoonover

Resident Engineer Huntington at: UW

Pit or Source ~~IXT Pit~~ Cross H Pit County Johnson

Sample Distribution

☐ Soils ☒ Aggregate ☐ Concrete ☐ Chemistry ☐ Geology

Sample Number(s) UW-S-VSPA S # ______ TH # ______ Multiple Samples 1 of 1

Location (Belt, Stockpile, etc.) Stockpile at: (Sta., kp., M.P., etc.) ~~IXT Pit~~ JD G Yard

Vertical Limits ______ to: ______

Horizontal Limits ______ to: ______

Quantity Represented ______

For Use As:

☐ Profile	☐ BSE	☐ PMP, Type ____ Grd. ____	☐ Conc. Coarse Aggregate
☐ Borrow	☐ CB, Grd. ____	☐ RPMP ____	☐ Conc. Med. Aggregate
☐ Topping	☐ PMB	☐ PMWC, Type ____	☐ Conc. Fine Aggregate
☐ Alkali	☐ CTB	☐ CCA, Type ____	☐ Conc. Cylinders
☐ Check Curve	☐ Filler	☐ Maint. Type ____	☐ Conc. Beams
☐ Final Emb.	☐ Drain Gravel	☐ Check Design	☐ Port. Cement, Type ____
☒ Other Surfacing			Type ____

Geosynthetics (Geogrid/Geotextile)

Product Name ______ Manufacturer ______

Remarks: Wash gradation; PL; LL; cohesion value; R-value; fractured faces; hydrometer (Geology)

Virgin Aggregate

Submitted By Scott Kocht

g:\materials\shared\forms\soil & surf-120.xls Reorder # FR-6042

5

WYOMING DEPARTMENT OF TRANSPORTATION
MATERIALS LABORATORY
REPORT OF TEST ON SURFACING MATERIALS

Form T-
Rev. 9-(
☐ En
☐ Me

LABORATORY NO. 08 1020 DATE REC'D
SUBMITTED BY Huntington AT
I.D. MARKS UW-Research - UW-S-VSPA DATE SCREENED 10-28
SOURCE Cross H Pit (Stockpiled) DATE SAMPLED 7-14
QUANTITY REPRESENTED 15K LOCATION
FOR USE AS Surfacing (Virgin Agg.) PROJECT CO

TEST RESULTS

SIEVE SIZE PASSING	RET. WT. LBS.	RET. WT. GRAMS	RET %	PASSING %	RET. WT. LBS.	RET. WT. GRAMS	RET %	PASSING %	RET. WT. LBS.	RET. WT. GRAMS	RET %	PASS %
MAX		500.9 421.5								"R" Value		
3" (75 mm)												
2" (50 mm)												
1 1/2 (3.75 mm)												
1" (25 mm)				100.0								
3/4" (19 mm)	0.7		2.0	98.0								
1/2" (12.5 mm)	5.0		14.5	83.5						198		
3/8" (9.50 mm)	2.7		7.8	75.7						292		
#4 (4.75 mm)	4.7		13.6	62.1						456		
#8 (2.36 mm)	21.1 / 21.5	92.6	11.6	50.5						1200		
#16 (1.18 mm)		62.2	7.7	42.8								
#30 (600 um)		56.8	7.0	35.8								
#50 (300 um)		81.8	10.1	25.7								
#100 (150 um)		70.5	8.7	17.0								
#200 (75 um)		44.3	5.5	11.5								
PAN	12.8	92.2 / 92.7										
	34.6									(4)		
LIQUID LIMIT	NV											
PLASTICITY INDEX	NP											
SAND EQUIVALENT												

Tests	Tech	Date
Screen	Cm	10-28
LL - PI		
Wash	MAS	10-28
Gradation	|	10-28
Crush		
Crush Wash		
CR LL PI		
LAR		

REMARKS UW-S-VSP(A)

Gradation ✓
LL = NV
PI = NP
CV = 517 PSI
"R" Value = 74
FF = 89.1 %
Hydrometer = See Work Sheet

UW-S-USP (A)

LAB NO. 08-1020 PIT Cross H Pit ENGINEER Huntington DATE TECH

LOCATION PROJECT UW Research

	A	B													
5:1 Ratio	Wt. Of sample	Weight of Flat & Elong. Particles	% F & E Particles	% retained weights	Weighted %		Wt. Of One or more fractured faces	% one or more F.F.	% retained weights	Weighted %		Wt. Of Two or more fractured faces	% Two or more F.F.	% retained weights	Wt %
SIEVE SIZE															
Coarse															
-3/4"+1/2"						600.0	528.8	88.1	0.435	38.3					
-1/2"+3/8"						400.0	370.3	92.6	0.206	19.1					
-3/8"+#4						80.0	70.7	88.4	0.359	31.7					
Medium															
-3/4"+1/2"															
-1/2"+3/8"															
-3/8"+#4															
Fines															
-1/2"+3/8"															
-3/8"+#4															
Filler															
-1/2"+3/8"															
-3/8"+#4															
								89.7							
Weighted Total %										89.1					

Flat & Elongated Formula

(B / A) X 100 = %

To calculate the weighted %, the +#4 needs to be adjusted so when all the new retained weights of the +#4 are added together, they equal 100%. Multiply the % of flat & elong. times the % retained of that sieve. Then multiply that times each bin split if there are multiple stockpiles if necessary. Add the weighted %'s on the various sieve sizes and report.

Note:
Flat test = width to thickness
Elongated test = length to width
Flat & Elongated = length to thickness

Wt % = weighted %

Note: The sieve size containing less than 10% will use the same % of flat & elongated as the sieve above it or below it.

Fractured Face Formula:
P=[F/(F+N)] X 100

F= Fractured Faces
N= No fractured faces
P= Percent of fractured faces

flatelong.xls

UW Research

Form T-115
Rev. 5/91

WYOMING DEPARTMENT OF TRANSPORTATION

SOILS STABILOMETER WORK SHEET

TEST SPECIMEN	A	B	C	D
MOLD NO.	19	55	26	
COMPACTOR AIR PRES.-PSI	350	350	350	
INITIAL MOIST. – %	—	—	—	
WATER ADDED – ML	80	100	90	
WATER ADDED – %	—	—	—	
MOIST AT COMPACTION %	6.7	8.3	7.5	
WET WEIGHT OF PAT – GMS	1214	1256	1203	
HEIGHT OF PAT – INCHES	2.51	2.62	2.68	
DENSITY – LB. PER CU. FT.	137.3	134.1	126.5	
STAB. Ph AT 1000 LBS	7	16	10	
2000 LBS.	15	35	25	
DISPLACEMENT	5.21	4.74	5.00	
"R" VALUE	82	65/68	73/76	
EXUDATION PRESS. PSI	750	150	360	

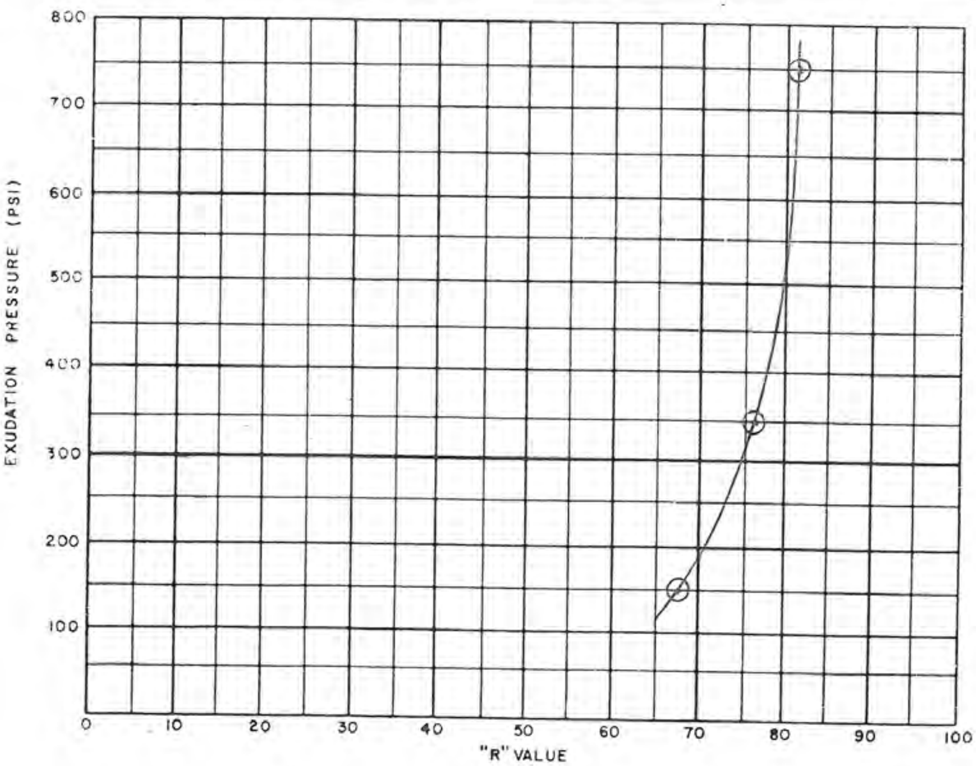
LL	PL	PI	LAB. NO.
			08 1020

SOIL CLASS & GROUP INDEX	PROJECT

FIELD IDENT.				STATION
INITIAL MOISTURE				1"
WET		DRY		3/4"
DRY		TARE		3/8"
WT. WATER		WT. DRY		NO. 4

EXPANSION SPECIMEN	A	B	C	D
DIAL READING	0	0	6	
COVER REQUIRED – INCHES				

TIN NO.	REMARKS:	T-115A
	UW-S-VSP (A)	"R" VALUE 74



WYOMING DEPARTMENT OF TRANSPORTATION
MATERIALS TESTING LABORATORY

REV. 5/96
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REPORT OF NATURAL CEMENTATION OF AGGREGATE FINES

REPORT NO. 08-1020 VSP-A
PROJECT NUMBER
ENGINEER
DATE
SOURCE UW- Research
FOR USE AS

TEST RESULTS

F + H²0 = 683.1
F + M + H²0 = 981.3
MATERIAL + TARE = 773.5
O.D. = 490.1

TARE PAN 283.4 g.

BULK = O.D. / (F + H²0 + 500 - F,M,H²0) = 2.429

APPARENT = O.D / (F + H²0 + O.D. - F,M,H²0) = 2.554

	FLASK	F + M	F + H²0
1	183.3	683.3	683.0
2	170.2	670.2	668.4
3	184.8	684.8	682.6

Moisture @ S.S.E.

MOISTURE SAMPLE FROM -4 S/G

TARE WEIGHT 283.4
WET WEIGHT 500.0
- DRY WEIGHT 490.1
= WT. OF MOISTURE 9.9

WT. OF MOISTURE 9.9
÷ DRY WEIGHT 490.1
MOISTURE % @ S.S.D. 2.0

95 ml

MOISTURE @ S.S.D + 5% FOR COMPACTION

MOISTURE @ COMPACTION

MOISTURE SAMPLE FROM EXCESS MATERIAL AFTER COMPACTION

TARE WEIGHT
WET WEIGHT 414.4
- DRY WEIGHT 386.5
= WT. OF MOISTURE 27.9

WT. OF MOISTURE 27.9
÷ DRY WEIGHT 386.5
MOIST. % @ COMPACTION 6.7

	MACHINE LOAD				PSI
1	2147	÷	4	=	537
2	1962	÷	4	=	491
3	2094	÷	4	=	524
AVG.	2068			AVG.	517

MOLD
OILED [X]
UNOILED [ ]

APPARENT S/G		BULK S/G	
MOISTURE @ S.S.D		ABSORBTION %	
MOISTURE @ COMPACTION			

NOTES:30ml=2% moisture

TESTED BY

ENGINEER

GRAIN SIZE DISTRIBUTION TEST DATA

Project: U.W. Research
Project Number:
Client: G. Huntington

Sample Data

Source: UW-S-VSPA
Sample No.: 81024
Elev. or Depth:
Sample Length(in./cm.):
Location: Cross H Pit
Description: Clayey sand

Mechanical Analysis Data

	Initial
Dry sample and tare=	694.70
Tare =	0.00
Dry sample weight =	694.70

Sample split on number 10 **sieve**
Split sample data:
Sample and tare = 71.81 **Tare =** .00 **Sample weight =** 71.81
Cumulative weight retained tare= .00
Tare for cumulative weight retained= .00

Sieve	Cumul. Wt. retained	Percent finer
# 4	0.69	99.9
# 10	124.69	82.1
# 20	14.96	65.0
# 40	28.53	49.5
# 100	45.01	30.6
# 200	50.31	24.6

Hydrometer Analysis Data

Separation sieve is #10
Percent -#10 based upon complete sample= 82.1
Weight of hydrometer sample: 80.5472.31
Hygroscopic moisture correction:
Moist weight & tare = 134.18
Dry weight & tare = 133.68
Tare = 61.42
Hygroscopic moisture= 0.7 %
Calculated biased weight= 97.43
Automatic temperature correction
Composite correction at 20 deg C = -6.7

Meniscus correction only= 0
Specific gravity of solids= 2.673
Specific gravity correction factor= 0.995
Hydrometer type: 152H
Effective depth L= 16.294964 - 0.164 x Rm

Elapsed time, min	Temp, deg C	Actual reading	Corrected reading	K	Rm	Eff. depth	Diameter mm	Percent finer
2.00	18.0	20.0	12.8	0.0139	20.0	13.0	0.0355	13.1
5.00	18.0	19.0	11.8	0.0139	19.0	13.2	0.0226	12.1
10.00	18.0	17.5	10.3	0.0139	17.5	13.4	0.0161	10.6

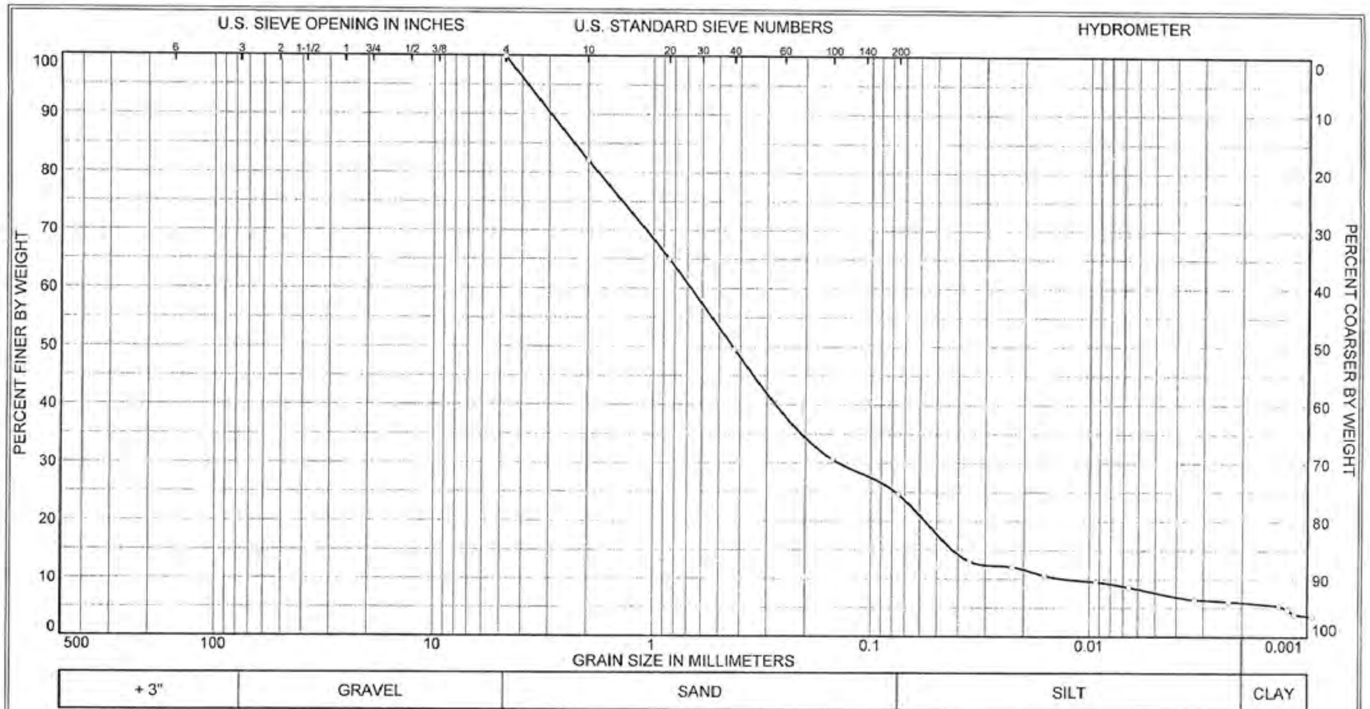
WYDOT GEOLOGY

Elapsed time, min	Temp, deg C	Actual reading	Corrected reading	K	Rm	Eff. depth	Diameter mm	Percent finer
30.00	18.0	16.5	9.3	0.0139	16.5	13.6	0.0094	9.5
60.00	18.5	15.5	8.4	0.0138	15.5	13.8	0.0066	8.6
240.00	20.0	13.0	6.3	0.0136	13.0	14.2	0.0033	6.4
480.00	21.0	12.5	6.0	0.0134	12.5	14.2	0.0023	6.1
1440.00	20.0	12.0	5.3	0.0136	12.0	14.3	0.0014	5.4
1680.00	21.5	11.0	4.6	0.0133	11.0	14.5	0.0012	4.7
1920.00	22.5	10.0	3.8	0.0131	10.0	14.7	0.0011	3.9
2880.00	21.0	10.0	3.5	0.0134	10.0	14.7	0.0010	3.5

Fractional Components

Gravel/Sand based on #4
Sand/Fines based on #200
% **+ 3" =** % **GRAVEL =** % **SAND =** 75.3
% **SILT =** 18.7 % **CLAY =** 6.0 **(**% **CLAY COLLOIDS =** 3.6**)**

D_{85}= 2.31 D_{60}= 0.68 D_{50}= 0.43
D_{30}= 0.14 D_{15}= 0.04 D_{10}= 0.01
C_c= 2.2358 C_u= 51.5095



LOCATION	SOURCE	SAMPLE #	DEPTH/ELEV.	MATERIAL DESCRIPTION
Cross H Pit	UW-S-VSPA	81024		Clayey sand

Project No. **Client** G. Huntington **Report Date**

Particle Size Distribution Report

U.W. Research

WYDOT GEOLOGY
Cheyenne, WY

WYOMING DEPARTMENT OF TRANSPORTATION

Form T-120
REVISED 8/99

Materials Testing Laboratory

SAMPLE TRANSMITTAL

☐ Metric ☑ English ☑ Preliminary ☐ Construction ☐ QC/QA

		Lab #	
Date Sampled	7-14-08	**Date Received**	
Project Number	UW - RESEARCH	**Road Section**	SCHOONOVER
Resident Engineer	HUNTINGTON	**at :**	UW
Pit or Source	CROSS H PIT	**County**	JOHNSON

Sample Distribution

☐ Soils ☑ Aggregate ☐ Concrete ☐ Chemistry ☐ Geology

Multiple Samples 1 of 1

Sample Number(s) UW-S-VSPB S # ____ TH # ____

Location (Belt, Stockpile, etc.) STOCKPILE at: (Sta., kp., M.P., etc.) JO. CO. YARD

Vertical Limits ____ to : ____

Horizontal Limits ____ to : ____

Quantity Represented ____

For Use As :

☐ Profile	☐ BSE	☐ PMP, Type ____ Grd. ____	☐ Conc. Coarse Aggregate
☐ Borrow	☐ CB, Grd. ____	☐ RPMP ____	☐ Conc. Med. Aggregate
☐ Topping	☐ PMB	☐ PMWC, Type ____	☐ Conc. Fine Aggregate
☐ Alkali	☐ CTB	☐ CCA, Type ____	☐ Conc. Cylinders
☐ Check Curve	☐ Filler	☐ Maint. Type ____	☐ Conc. Beams
☐ Final Emb.	☐ Drain Gravel	☐ Check Design	☐ Port. Cement, Type ____
☑ Other SURFACING			Type ____

Geosynthetics (Geogrid/Geotextile)

Product Name ____ **Manufacturer** ____

Remarks: WASH GRADATION; PL; LL; COHESION VALUE
R VALUE FRACTURED FACES HYDROMETER (GEOLOGY)

VIRGIN AGGREGATE

Submitted By SCOTT KOCH

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Reorder # FR-6042

WYOMING DEPARTMENT OF TRANSPORTATION
MATERIALS LABORATORY
REPORT OF TEST ON SURFACING MATERIALS

Form T-
Rev. 8-C
☐ En
☐ Me

LABORATORY NO. 08 1020 DATE REC'D
SUBMITTED BY Huntington AT
I.D. MARKS UW-Research - UW-S-VSPB DATE SCREENED 10-28
SOURCE Cross H Pit (Stockpiled) DATE SAMPLED 7-14
QUANTITY REPRESENTED 15k LOCATION
FOR USE AS Surfacing (Virgin Agg.) PROJECT CO

TEST RESULTS

SIEVE SIZE PASSING	RET. WT. LBS.	RET. WT. GRAMS	RET %	PASSING %	RET. WT. LBS.	RET. WT. GRAMS	RET %	PASSING %	RET. WT. LBS.	RET. WT. GRAMS	RET %	PASS %
MAX		461.8 390.1								"R" Value		
3" (75 mm)												
2" (50 mm)												
1 1/2 (3.75 mm)												
1" (25 mm)				100.0								
3/4" (19 mm)	0.6		1.6	98.4								
1/2" (12.5 mm)	4.6		12.4	86.0						168		
3/8" (9.50 mm)	3.1		8.3	77.7						268		
#4 (4.75 mm)	5.2		14.0	63.7						436		
#8 (2.36 mm)	23.4 / 23.7	70.9	9.8	53.9						1200		
#16 (1.18 mm)		57.0	7.9	46.0								
#30 (600 um)		56.9	7.8	38.2								
#50 (300 um)		85.5	11.8	26.4								
#100 (150 um)		65.2	9.0	17.4								
#200 (75 um)		44.3	6.1	11.3								
PAN	10.3	82.0 / 82.0										
	37.2									(4)		
LIQUID LIMIT	NV											
PLASTICITY INDEX	NP											
SAND EQUIVALENT												

Tests	Tech	Date
Screen	Cm	10-28
LL - PI		
Wash	MS	10-29
Gradation	⟂	10-28
Crush		
Crush Wash		
CR. LL PI		
LAR		

REMARKS UW-S-VSP(B)

Gradation ✓
LL: = NV
PI: = NP
CV = 401 PSI
"R" Value = 79
FF = 91.6%
Hydrometer = See Work Sheet

UW-S-VSP (B)

LAB NO. 08-1020 PIT Cross E pit LOCATION ENGINEER Huntington PROJECT UW Research DATE TECH

	A	B													
5:1 Ratio	Wt. Of sample	Weight of Flat & Elong. Particles	% F & E Particles	% retained weights	Weighted %		Wt. Of One or more fractured faces	% one or more F.F.	% retained weights	Weighted %		Wt. Of Two or more fractured faces	% Two or more F.F.	% retained weights	Wt %
SIEVE SIZE															
Coarse															
-3/4"+1/2"						600.0	577.2	96.2	0.386	37.1					
-1/2"+3/8"						400.0	365.7	91.4	0.228	20.8					
-3/8"+#4						80.0	69.8	87.3	0.366	33.7					
Medium															
-3/4"+1/2"															
-1/2"+3/8"															
-3/8"+#4															
Fines															
-1/2"+3/8"															
-3/8"+#4															
Filler															
-1/2"+3/8"															
-3/8"+#4								91.6							
Weighted Total %										91.6					

Flat & Elongated Formula

(B / A) X 100 = %

To calculate the weighted %, the +#4 needs to be adjusted so when all the new retained weights of the +#4 are added together, they equal 100%. Multiply the % of flat & elong. times the % retained of that sieve. Then multiply that times each bin split if there are multiple stockpiles if necessary. Add the weighted %'s on the various sieve sizes and report.

Note:
Flat test = width to thickness
Elongated test = length to width
Flat & Elongated = length to thickness

Wt % = weighted %

Note: The sieve size containing less than 10% will use the same % of flat & elongated as the sieve above it or below it.

Fractured Face Formula:
P=[F/(F+N)] X 100

F= Fractured Faces
N= No fractured faces
P= Percent of fractured faces

flatelong.xls

Form T-115
Rev. 5/91

UW Research

WYOMING DEPARTMENT OF TRANSPORTATION

SOILS STABILOMETER WORK SHEET

TEST SPECIMEN	A	B	C	D
MOLD NO.	37	47	13	
COMPACTOR AIR PRES.-PSI	350	350	350	
INITIAL MOIST.-%				
WATER ADDED-ML	80	100	90	
WATER ADDED-%				
MOIST AT COMPACTION %	6.7	8.3	7.5	
WET WEIGHT OF PAT-GMS	1213	1241	1234	
HEIGHT OF PAT-INCHES	2.57	2.59	2.61	
DENSITY-LB. PER CU. FT.	134.0	134.1	133.3	
STAB. Ph AT 1000 LBS	8	15	12	
2000 LBS.	16	30	23	
DISPLACEMENT	4.91	4.78	4.66	
"R" VALUE	82	69	76/79	
EXUDATION PRESS. PSI	750	150	300	

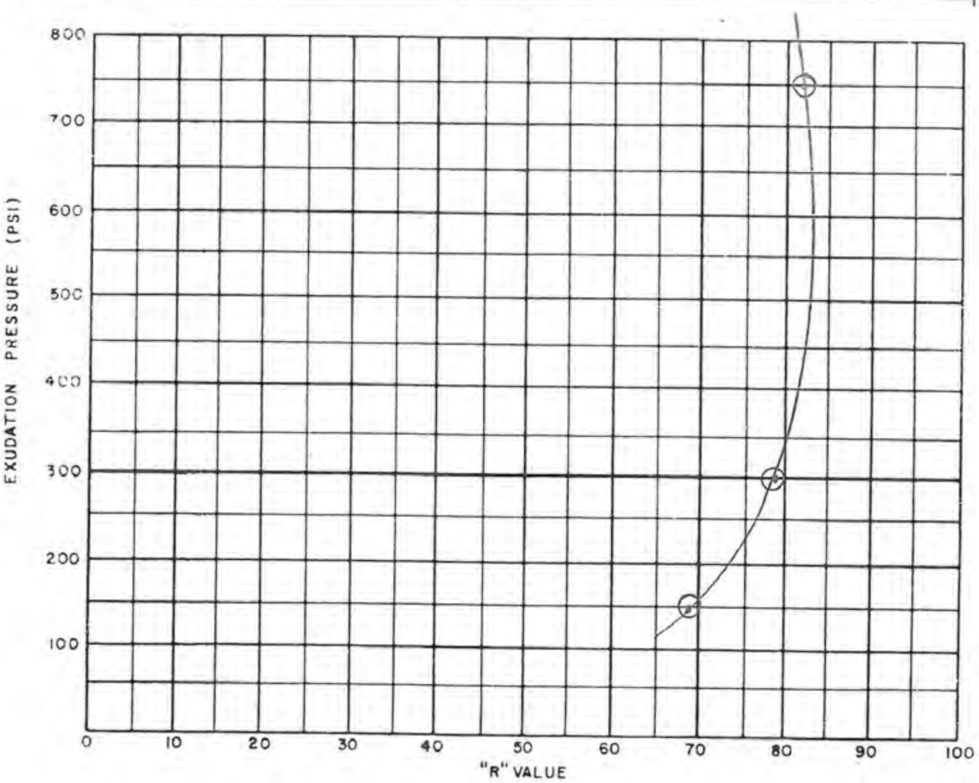
LL	PL	PI	LAB. NO
			08-1020

SOIL CLASS & GROUP INDEX	PROJECT

FIELD IDENT				STATION
INITIAL MOISTURE				1"
WET		DRY		3/4"
DRY		TARE		3/8"
WT WATER		WT. DRY		NO. 4

EXPANSION SPECIMEN	A	B	C	D
DIAL READING	0	0	0	
COVER REQUIRED-INCHES				

TIN NO.	REMARKS:	T-115A
	UW-5-VSP (B)	"R" VALUE 79



WYOMING DEPARTMENT OF TRANSPORTATION
MATERIALS TESTING LABORATORY

REV. 5/96
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REPORT OF NATURAL CEMENTATION OF AGGREGATE FINES

REPORT NO. 08-1020 VSP-B
PROJECT NUMBER
ENGINEER
DATE
SOURCE UW - Research
FOR USE AS

TEST RESULTS

F + H²0 = 677.2			O.D. / F + H²0 + 500 - F,M,H²0	BULK = 2.456
F + M + H²0 = 977.8	TARE PAN			
MATERIAL + TARE = 825.2	335.5 g.		O.D / F + H²0 + O.D. - F,M,H²0	APPARENT : 2.590
O.D. = 489.7				

	FLASK	F + M	F + H²0
1	183.3	683.3	683.0
2	170.2	670.2	668.4
3	184.8	684.8	682.6

Moisture @ S.S.E.
MOISTURE SAMPLE FROM -4 S/G

TARE WEIGHT	335.5		
WET WEIGHT	500.0	WT. OF MOISTURE	10.3
- DRY WEIGHT	489.7	÷ DRY WEIGHT	489.7
= WT. OF MOISTURE	10.3	MOISTURE % @ S.S.D.	2.0%

95 mL

MOISTURE @ S.S.D + 5% FOR COMPACTION

MOISTURE @ COMPACTION
MOISTURE SAMPLE FROM EXCESS MATERIAL AFTER COMPACTION

TARE WEIGHT			
WET WEIGHT	514.0	WT. OF MOISTURE	35.0
- DRY WEIGHT	479.0	÷ DRY WEIGHT	479.0
= WT. OF MOISTURE	35.0	MOIST. % @ COMPACTION	6.8

	MACHINE LOAD				PSI	MOLD
1	1703	÷	4	=	426	
2	1270	÷	4	=	318	OILED ☐
3	1839	÷	4	=	460	UNOILED ☐
AVG.	1604			AVG.	401	

APPARENT S/G		BULK S/G	
MOISTURE @ S.S.D		ABSORBTION %	
MOISTURE @ COMPACTION			

NOTES:30ml=2% moisture

TESTED BY

ENGINEER

GRAIN SIZE DISTRIBUTION TEST DATA

Project: U.W. Research
Project Number: **Client:** G. Huntington

Sample Data

Source: UW-S-VSPB
Sample No.: 81025
Elev. or Depth: **Sample Length(in./cm.):**
Location: Cross H Pit
Description: Silty sand

Mechanical Analysis Data

	Initial
Dry sample and tare=	623.20
Tare =	0.00
Dry sample weight =	623.20

Sample split on number 10 sieve
Split sample data:
Sample and tare = 64.57 Tare = .00 Sample weight = 64.57
Cumulative weight retained tare= .00
Tare for cumulative weight retained= .00

Sieve	Cumul. Wt. retained	Percent finer
3 inch	0.00	100.0
1.5 inch	0.00	100.0
.75 inch	0.00	100.0
.375 inch	0.00	100.0
# 4	2.15	99.7
# 10	69.11	88.9
# 20	8.28	77.5
# 40	20.08	61.3
# 100	38.06	36.5
# 200	44.52	27.6

Hydrometer Analysis Data

Separation sieve is #10
Percent -#10 based upon complete sample= 88.9
Weight of hydrometer sample: 65.01
Hygroscopic moisture correction:
Moist weight & tare = 124.76
Dry weight & tare = 124.32
Tare = 60.31
Hygroscopic moisture= 0.7 %
Calculated biased weight= 72.63
Automatic temperature correction
Composite correction at 20 deg C = -6.7

Meniscus correction only= 0
Specific gravity of solids= 2.71
Specific gravity correction factor= 0.987
Hydrometer type: 152H
Effective depth L= 16.294964 - 0.164 x Rm

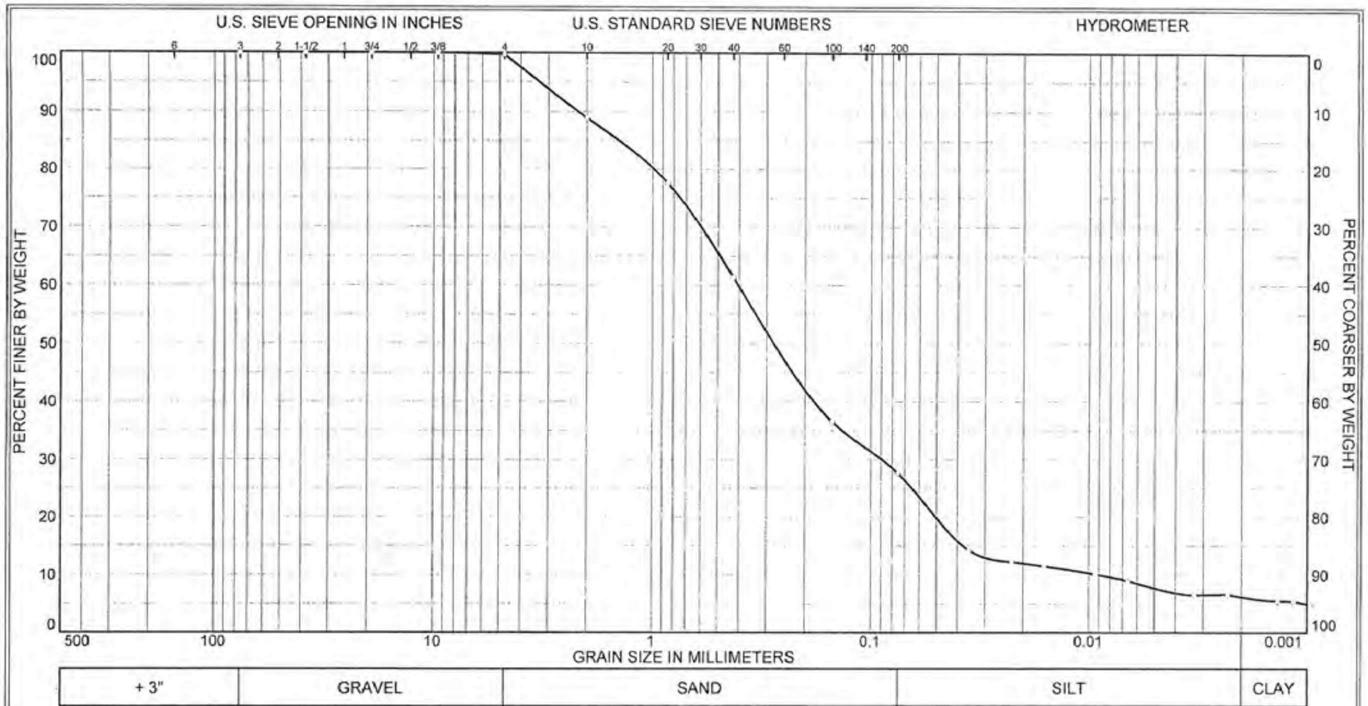
WYDOT GEOLOGY

Elapsed time, min	Temp, deg C	Actual reading	Corrected reading	K	Rm	Eff. depth	Diameter mm	Percent finer
2.00	18.5	17.5	10.4	0.0137	17.5	13.4	0.0354	14.2
5.00	18.5	16.0	8.9	0.0137	16.0	13.7	0.0226	12.2
10.00	18.5	15.5	8.4	0.0137	15.5	13.8	0.0160	11.5
30.00	18.5	14.5	7.4	0.0137	14.5	13.9	0.0093	10.1
60.00	19.0	13.5	6.6	0.0136	13.5	14.1	0.0066	8.9
240.00	20.0	11.5	4.8	0.0134	11.5	14.4	0.0033	6.5
480.00	20.5	11.5	4.9	0.0133	11.5	14.4	0.0023	6.6
1440.00	19.0	11.0	4.1	0.0136	11.0	14.5	0.0014	5.5
1920.00	21.0	10.5	4.0	0.0132	10.5	14.6	0.0012	5.4
2880.00	19.0	10.5	3.6	0.0136	10.5	14.6	0.0010	4.8

Fractional Components

Gravel/Sand based on #4
Sand/Fines based on #200
% **+ 3"** = 0.0 % **GRAVEL** = 0.3 % **SAND** = 72.1
% **SILT** = 21.4 % **CLAY** = 6.2 (% **CLAY COLLOIDS** = 4.9)

D_{85}= 1.42 D_{60}= 0.40 D_{50}= 0.28
D_{30}= 0.09 D_{15}= 0.04 D_{10}= 0.01
C_c= 2.1606 C_u= 44.9912



LOCATION	SOURCE	SAMPLE #	DEPTH/ELEV.	MATERIAL DESCRIPTION
Cross H Pit	UW-S-VSPB	81025		Silty sand

Project No. **Client** G. Huntington **Report Date** 1/8/2009

Particle Size Distribution Report

U.W. Research

WYDOT GEOLOGY

Cheyenne, WY

WYOMING DEPARTMENT OF TRANSPORTATION

Materials Testing Laboratory

SAMPLE TRANSMITTAL

Form T-120
REVISED 8/99

- [ ] Metric
- [x] English
- [x] Preliminary
- [ ] Construction
- [ ] QC/QA

Lab # ______

Date Sampled 7-14-08 **Date Received** ______

Project Number UW - RESEARCH **Road Section** SCHOONOVER

Resident Engineer HUNTINGTON **at:** UW

Pit or Source CROSS H PIT **County** JOHNSON

Sample Distribution

- [ ] Soils
- [x] Aggregate
- [ ] Concrete
- [ ] Chemistry
- [ ] Geology

Multiple Samples 1 of 1

Sample Number(s) UW - S - VSPC S # ______ TH # ______

Location (Belt, Stockpile, etc.) STOCKPILE at: (Sta., kp., M.P., etc.) JO. CO YARD

Vertical Limits ______ to: ______

Horizontal Limits ______ to: ______

Quantity Represented ______

For Use As :

- [ ] Profile
- [ ] BSE
- [ ] PMP, Type ______ Grd. ______
- [ ] Conc. Coarse Aggregate
- [ ] Borrow
- [ ] CB, Grd. ______
- [ ] RPMP ______
- [ ] Conc. Med. Aggregate
- [ ] Topping
- [ ] PMB
- [ ] PMWC, Type ______
- [ ] Conc. Fine Aggregate
- [ ] Alkali
- [ ] CTB
- [ ] CCA, Type ______
- [ ] Conc. Cylinders
- [ ] Check Curve
- [ ] Filler
- [ ] Maint. Type ______
- [ ] Conc. Beams
- [ ] Final Emb.
- [ ] Drain Gravel
- [ ] Check Design
- [ ] Port. Cement, Type ______
- [x] Other SURFACING Type ______

Geosynthetics (Geogrid/Geotextile)

Product Name ______ **Manufacturer** ______

Remarks: WASH GRADATION; PL; LL, COHESION VALUE; R. VALUE
FRACTURED FACES; HYDROMETER (GEOLOGY)

VIRGIN AGGREGATE

Submitted By Scott Koch

g:\materials\shared\forms\soil & surf-120.xls

Reorder # FR-8042

5

WYOMING DEPARTMENT OF TRANSPORTATION
MATERIALS LABORATORY
REPORT OF TEST ON SURFACING MATERIALS

Form T-
Rev 9-0
☐ En
☐ Me

LABORATORY NO. 60 1020 DATE REC'D
SUBMITTED BY Huntington AT
I.D MARKS UW-Research-UW-S-VSPC DATE SCREENED 10-29
SOURCE Cross H Pit (Stockpiled) DATE SAMPLED 7-14
QUANTITY REPRESENTED 1 sk LOCATION
FOR USE AS Surfacing Virgin Agg. PROJECT CO

TEST RESULTS

SIEVE SIZE PASSING	RET. WT. LBS.	RET. WT. GRAMS	RET %	PASSING %	RET. WT. LBS.	RET. WT. GRAMS	RET %	PASSING %	RET. WT. LBS.	RET. WT. GRAMS	RET %	PASS %
MAX		401-1 328.7								"R" Value		
3" (75 mm)												
2" (50 mm)												
1 1/2 (3.75 mm)				100.0								
1" (25 mm)	0.1		0.2	99.8								
3/4" (19 mm)	0.7		1.8	98.0								
1/2" (12.5 mm)	6.1		15.5	82.5						210		
3/8" (9.50 mm)	3.4		8.7	73.8						314		
#4 (4.75 mm)	5.2		13.2	60.6						472		
#8 (2.36 mm)	23.1 / 23.8	52.0	7.8	52.8						1200		
#16 (1.18 mm)		48.2	7.3	45.5								
#30 (600 um)		49.9	7.5	38.0								
#50 (300 um)		77.2	11.7	26.3								
#100 (150 um)		59.0	8.9	17.4								
#200 (75 um)		35.5	5.4	12.0								
PAN	6.5	78.9 / 79.3										
	39.3									(4)		
LIQUID LIMIT	NV											
PLASTICITY INDEX	NP											
SAND EQUIVALENT												

Tests	Tech	Date
Screen	Cn	10-28
LL - PI		
Wash	MRS	10-28
Gradation	↓	↓
Crush		
Crush Wash		
CR LL PI		
LAR		

REMARKS UW-S-VSP(C)

Gradation ✓
LL = NV
PI = NP
CV = 420 PSI
'R' Value = 71
FF = 90.2%
Hydrometer = See Work Sheet

UW-2 VSP (L)

LAB NO. 08-1020 PIT Cross L pit ENGINEER Huntington DATE TECH

LOCATION PROJECT UW Research

	A	B													
5:1 Ratio	Wt. Of sample	Weight of Flat & Elong. Particles	% F & E Particles	% retained weights	Weighted %		Wt. Of One or more fractured faces	% one or more F.F.	% retained weights	Weighted %		Wt. Of Two or more fractured faces	% Two or more F.F.	% retained weights	Wt %
SIEVE SIZE															
Coarse															
-3/4"+1/2"						600.0	535.2	89.2	0.444	39.6					
-1/2"+3/8"						400.0	362.3	90.6	0.221	20.0					
-3/8"+#4						80.0	73.0	91.3	0.335	30.6					
Medium															
-3/4"+1/2"															
-1/2"+3/8"															
-3/8"+#4															
Fines															
-1/2"+3/8"															
-3/8"+#4															
Filler															
-1/2"+3/8"															
-3/8"+#4															
							90.4								
Weighted Total %										90.2					

Flat & Elongated Formula

(B / A) X 100 = %

To calculate the weighted %, the +#4 needs to be adjusted so when all the new retained weights of the +#4 are added together, they equal 100%. Multiply the % of flat & elong. times the % retained of that sieve. Then multiply that times each bin split if there are multiple stockpiles if necessary. Add the weighted %'s on the various sieve sizes and report.

Note:
Flat test = width to thickness
Elongated test = length to width
Flat & Elongated = length to thickness

Wt % = weighted %

Note: The sieve size containing less than 10% will use the same % of flat & elongated as the sieve above it or below it.

Fractured Face Formula:
P=[F/(F+N)] X 100

F= Fractured Faces
N= No fractured faces
P= Percent of fractured faces

flatelong.xls

UW Research

Form T-115
Rev. 5/91

WYOMING DEPARTMENT OF TRANSPORTATION

SOILS STABILOMETER WORK SHEET

TEST SPECIMEN	A	B	C	D
MOLD NO.	1	10	21	
COMPACTOR AIR PRES.-PSI	350	350	350	
INITIAL MOIST.—%	—	—	—	
WATER ADDED—ML	80	100	90	
WATER ADDED—%	—	—	—	
MOIST AT COMPACTION %	6.7	8.3	7.5	
WET WEIGHT OF PAT—GMS	1218	1273	1209	
HEIGHT OF PAT—INCHES	2.61	2.49	2.51	
DENSITY—LB. PER CU. FT.	132.5	138.5	135.8	
STAB. Ph AT 1000 LBS	11	18	14	
2000 LBS.	23	41	29	
DISPLACEMENT	4.37	4.77	4.71	
"R" VALUE	77/79	60	71	
EXUDATION PRESS. PSI	750	150	300	

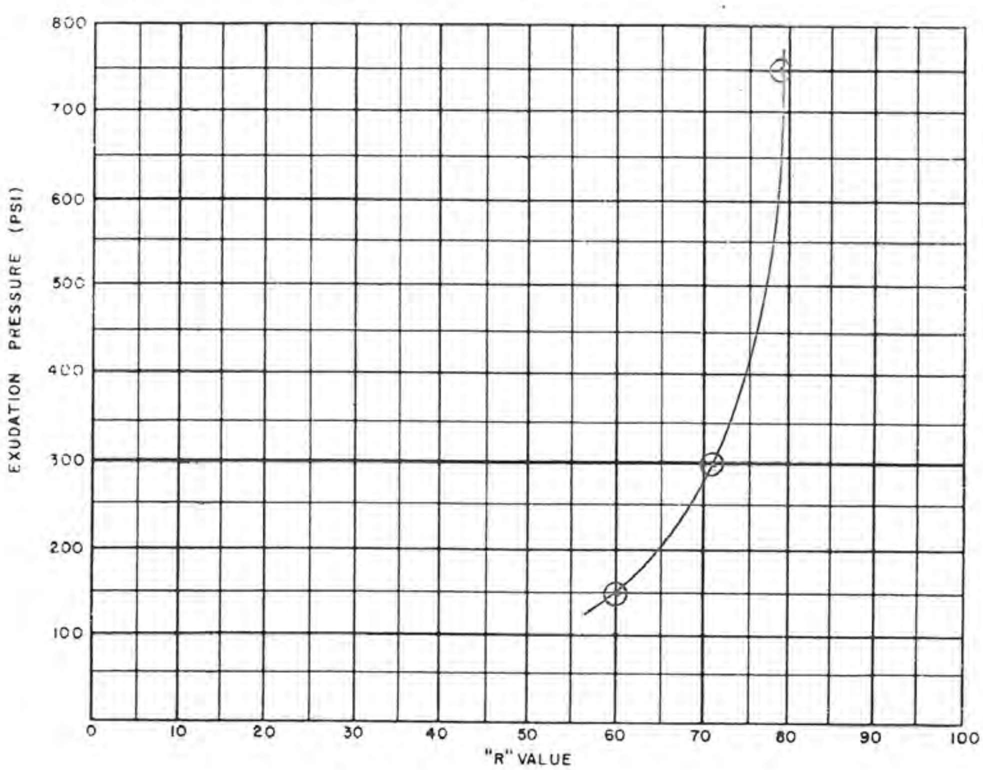
LL	PL	PI	LAB. NO
			08 1020

SOIL CLASS & GROUP INDEX	PROJECT

FIELD IDENT				STATION
INITIAL MOISTURE				1"
WET		DRY		3/4"
DRY		TARE		3/8"
WT. WATER		WT. DRY		NO. 4

EXPANSION SPECIMEN	A	B	C	D
DIAL READING	0	0	0	
COVER REQUIRED—INCHES				

TIN NO.	REMARKS:	T-115A
	UW-5-VSP (L)	"R" VALUE 71



WYOMING DEPARTMENT OF TRANSPORTATION
MATERIALS TESTING LABORATORY

REV. 5/96
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REPORT OF NATURAL CEMENTATION OF AGGREGATE FINES

REPORT NO. 1020 - VSP - C
PROJECT NUMBER
ENGINEER

DATE
SOURCE UW - Research
FOR USE AS

TEST RESULTS

F + H²O = 677.2
F + M + H²O = 980.1
MATERIAL + TARE = 780.3
O.D. = 490.4

TARE PAN 289.9 g.

BULK = O.D. / (F + H²O + 500 - F,M,H²O) = 2.488

APPARENT = O.D / (F + H²O + O.D. - F,M,H²O) = 2.615

	FLASK	F + M	F + H²O
1	183.3	683.3	683.0
2	170.2	670.2	668.4
3	184.8	684.8	682.6

Moisture @ S.S.E.
MOISTURE SAMPLE FROM -4 S/G

TARE WEIGHT	289.9		
WET WEIGHT	500.0	WT. OF MOISTURE	9.6
- DRY WEIGHT	490.4	+ DRY WEIGHT	490.4
= WT. OF MOISTURE	9.6	MOISTURE % @ S.S.D.	2.0%

95 ML

MOISTURE @ S.S.D + 5% FOR COMPACTION

MOISTURE @ COMPACTION
MOISTURE SAMPLE FROM EXCESS MATERIAL AFTER COMPACTION

TARE WEIGHT			
WET WEIGHT	503.4	WT. OF MOISTURE	33.9
- DRY WEIGHT	469.5	+ DRY WEIGHT	469.5
= WT. OF MOISTURE	33.9	MOIST. % @ COMPACTION	6.7

	MACHINE LOAD				PSI
1	1805	÷	4	=	451
2	1588	÷	4	=	397
3	1644	÷	4	=	411
AVG.	1679			AVG.	420

MOLD
OILED ☐
UNOILED ☐

APPARENT S/G		BULK S/G	
MOISTURE @ S.S.D		ABSORBTION %	
MOISTURE @ COMPACTION			

NOTES:30ml=2% moisture

TESTED BY ____________ ENGINEER ____________

GRAIN SIZE DISTRIBUTION TEST DATA

Project: U.W. Research
Project Number: **Client:** G. Huntington

Sample Data

Source: UW-S-VSPC
Sample No.: 81026
Elev. or Depth: **Sample Length(in./cm.):**
Location: Cross H Pit
Description: Silty sand

Mechanical Analysis Data

	Initial
Dry sample and tare=	769.42
Tare =	0.00
Dry sample weight =	769.42

Sample split on number 10 **sieve**
Split sample data:
Sample and tare = 76.41 **Tare =** .00 **Sample weight =** 76.41
Cumulative weight retained tare= .00
Tare for cumulative weight retained= .00

Sieve	Cumul. Wt. retained	Percent finer
3 inch	0.00	100.0
1.5 inch	0.00	100.0
.75 inch	0.00	100.0
.375 inch	0.00	100.0
# 4	2.93	99.6
# 10	122.45	84.1
# 20	14.79	67.8
# 40	30.33	50.7
# 100	50.70	28.3
# 200	57.48	20.8

Hydrometer Analysis Data

Separation sieve is #10
Percent -#10 based upon complete sample= 84.1
Weight of hydrometer sample: 76.94
Hygroscopic moisture correction:
Moist weight & tare = 139.44
Dry weight & tare = 138.90
Tare = 61.68
Hygroscopic moisture= 0.7 %
Calculated biased weight= 90.85
Automatic temperature correction
Composite correction at 20 deg C = -6.7

Meniscus correction only= 0
Specific gravity of solids= 2.663
Specific gravity correction factor= 0.997
Hydrometer type: 152H
Effective depth L= 16.294964 - 0.164 x Rm

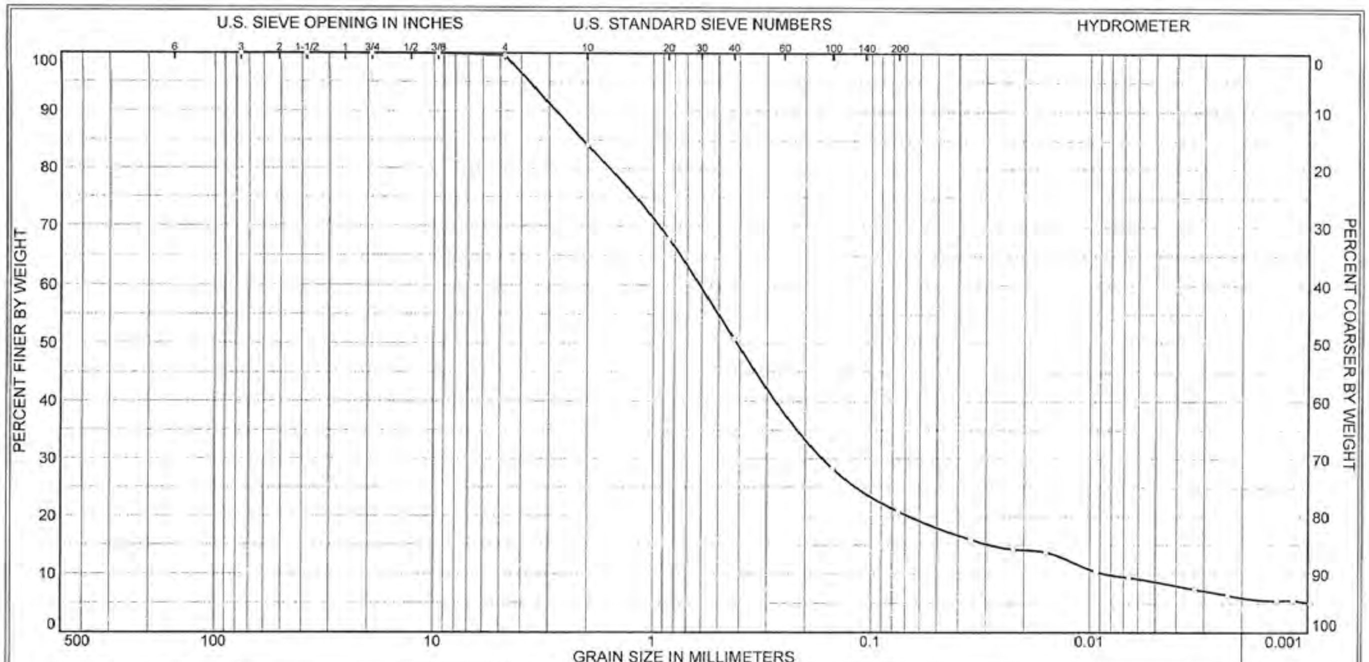
WYDOT GEOLOGY

Elapsed time, min	Temp, deg C	Actual reading	Corrected reading	K	Rm	Eff. depth	Diameter mm	Percent finer
2.00	18.5	21.5	14.4	0.0139	21.5	12.8	0.0350	15.9
5.00	18.5	20.0	12.9	0.0139	20.0	13.0	0.0223	14.2
10.00	18.5	19.5	12.4	0.0139	19.5	13.1	0.0159	13.7
30.00	18.5	16.5	9.4	0.0139	16.5	13.6	0.0093	10.4
60.00	19.0	15.5	8.6	0.0138	15.5	13.8	0.0066	9.4
240.00	20.0	13.5	6.8	0.0136	13.5	14.1	0.0033	7.4
480.00	20.5	12.5	5.9	0.0135	12.5	14.2	0.0023	6.4
1440.00	18.5	12.0	4.9	0.0139	12.0	14.3	0.0014	5.4
1920.00	21.0	11.5	5.0	0.0134	11.5	14.4	0.0012	5.5
2880.00	19.0	11.5	4.6	0.0138	11.5	14.4	0.0010	5.0

Fractional Components

Gravel/Sand based on #4
Sand/Fines based on #200
% **+ 3"** = 0.0 % **GRAVEL** = 0.4 % **SAND** = 78.8
% **SILT** = 14.9 % **CLAY** = 5.9 (% **CLAY COLLOIDS** = 5.1)

D_{85}= 2.10 D_{60}= 0.61 D_{50}= 0.41
D_{30}= 0.17 D_{15}= 0.03 D_{10}= 0.01
C_c= 5.3697 C_u= 72.4827



+ 3"	GRAVEL	SAND	SILT	CLAY

LOCATION	SOURCE	SAMPLE #	DEPTH/ELEV.	MATERIAL DESCRIPTION
Cross H Pit	UW-S-VSPC	81026		Silty sand

Project No. **Client** G. Huntington **Report Date** 1/8/2009

Particle Size Distribution Report

U.W. Research

WYDOT GEOLOGY
Cheyenne, WY

APPENDIX D

SAS CODE AND RESULTS

SAS Code for Dust Contrasts

```
DM LOG 'CLEAR';
DM OUTPUT 'CLEAR';

DATA Both_Counties_Average;
	INFILE 'R:\RAP Writings & Data\DATA\Statistical Analysis\Both Counties
	SAS\Average.csv' DLM = ',' DSD MISSOVER;
	INPUT  Section $ Dust Moisture Age Wind Pass;
	Log_Dust=log(Dust);
PROC PRINT DATA = Both_Counties_Average;
	TITLE 'Estimate No Pass Both Counties Average' ;
RUN;


ODS RTF FILE = 'R:\RAP Writings & Data\DATA\Statistical Analysis\Both Counties
SAS\Estimate No Pass Both Counties Average.rtf' BODYTITLE;

PROC GLM alpha = 0.10
DATA=Both_Counties_Average;
CLASS Section;
MODEL Log_Dust = Section Moisture Age Wind  /solution;
ESTIMATE 'Average Laramie vs Johnson' section 3 3 3 3 3 -5 -5 -5/ DIVISOR=15;
ESTIMATE 'Average noRAP vs RAP' section 5  -3 -3 5 -3 5 -3 -3/ DIVISOR=15;
ESTIMATE 'Average noCaCl vs CaCl' section 1 1 1 1 1 -3 -3 1/ DIVISOR=6;
output p=fit r=res out=datsec;
RUN;

ODS RTF CLOSE;
```

SAS Code for URCI Contrasts

```
DM LOG 'CLEAR';
DM OUTPUT 'CLEAR';

DATA Both_Counties_Average_URCI;
	INFILE 'R:\RAP Writings & Data\DATA\Statistical Analysis\Both Counties
SAS\AverageWithURCI.csv' DLM = ',' DSD MISSOVER;
	INPUT  Section $ URCI Dust Moisture Age Wind Pass;

PROC PRINT DATA = Both_Counties_Average_URCI;
	TITLE 'Estimate No Pass Both Counties Average URCI' ;
RUN;


ODS RTF FILE = 'R:\RAP Writings & Data\DATA\Statistical Analysis\Both Counties
SAS\Estimate No Pass Both Counties Average URCI.rtf' BODYTITLE;

PROC GLM alpha = 0.10
DATA=Both_Counties_Average_URCI;
CLASS Section;
MODEL URCI = Section Dust Moisture Age Wind  /solution;
ESTIMATE 'Average URCI Laramie vs Johnson' section 3 3 3 3 3 -5 -5 -5/ DIVISOR=15;
ESTIMATE 'Average URCI noRAP vs RAP' section 5  -3 -3 5 -3 5 -3 -3/ DIVISOR=15;
ESTIMATE 'Average URCI noCaCl vs CaCl' section 1 1 1 1 1 -3 -3 1/ DIVISOR=6;
output p=fit r=res out=datsec;
RUN;

ODS RTF CLOSE;
```

SAS Results for Average Contrasts

Estimate Both Counties Average

The GLM Procedure

Class Level Information		
Class	**Levels**	**Values**
Section	8	A0 A1 A2 P0 P1 S0 S1 S2

Number of Observations Read	96
Number of Observations Used	95

The GLM Procedure

Dependent Variable: Log_Dust

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	10	35.96941872	3.59694187	10.34	<.0001
Error	84	29.22510617	0.34791793		
Corrected Total	94	65.19452489			

R-Square	Coeff Var	Root MSE	Log_Dust Mean
0.551725	-123.8379	0.589846	-0.476305

Source	DF	Type I SS	Mean Square	F Value	Pr > F
Section	7	16.40863705	2.34409101	6.74	<.0001
Moisture	1	0.18007628	0.18007628	0.52	0.4739
Age	1	10.56048849	10.56048849	30.35	<.0001
Wind	1	8.82021690	8.82021690	25.35	<.0001

Source	DF	Type III SS	Mean Square	F Value	Pr > F
Section	7	28.53127923	4.07589703	11.72	<.0001
Moisture	1	0.10082701	0.10082701	0.29	0.5918
Age	1	7.93235049	7.93235049	22.80	<.0001
Wind	1	8.82021690	8.82021690	25.35	<.0001

Parameter	Estimate	Standard Error	t Value	Pr > |t|
Average Laramie vs Johnson	1.05741117	0.13723690	7.71	<.0001
Average noRAP vs RAP	0.38804705	0.13641207	2.84	0.0056
Average noCaCl vs CaCl	1.26457298	0.16427895	7.70	<.0001

Parameter	Estimate		Standard Error	t Value	Pr > |t|
Intercept	0.218606698	B	0.20751041	1.05	0.2951
Section A0	0.615692996	B	0.24718199	2.49	0.0147
Section A1	0.284570246	B	0.23352320	1.22	0.2264
Section A2	0.374399685	B	0.23112192	1.62	0.1090
Section P0	0.800149550	B	0.24199452	3.31	0.0014
Section P1	0.336765895	B	0.23837916	1.41	0.1614
Section S0	-0.430894872	B	0.26174894	-1.65	0.1035
Section S1	-1.294391623	B	0.25694116	-5.04	<.0001
Section S2	0.000000000	B	.	.	.
Moisture	0.047883216		0.08894740	0.54	0.5918
Age	-0.009349600		0.00195808	-4.77	<.0001
Wind	-0.074204682		0.01473771	-5.04	<.0001

SAS Results for URCI Contrasts

Estimate No Pass Both Counties Average URCI

The GLM Procedure

Class Level Information		
Class	**Levels**	**Values**
Section	8	A0 A1 A2 P0 P1 S0 S1 S2

Number of Observations Read	83
Number of Observations Used	82

Note: The X'X matrix has been found to be singular, and a generalized inverse was used to solve the normal equations. Terms whose estimates are followed by the letter 'B' are not uniquely estimable.

The GLM Procedure

Dependent Variable: URCI

Source	DF	Sum of Squares	Mean Square	F Value	Pr > F
Model	11	3286.317073	298.756098	16.90	<.0001
Error	70	1237.207317	17.674390		
Corrected Total	81	4523.524390			

R-Square	Coeff Var	Root MSE	URCI Mean
0.726495	4.626702	4.204092	90.86585

Source	DF	Type I SS	Mean Square	F Value	Pr > F
Section	7	2452.088027	350.298290	19.82	<.0001
Dust	1	128.604882	128.604882	7.28	0.0087

Source	DF	Type I SS	Mean Square	F Value	Pr > F
Moisture	1	83.787327	83.787327	4.74	0.0328
Age	1	612.437535	612.437535	34.65	<.0001
Wind	1	9.399302	9.399302	0.53	0.4683

Source	DF	Type III SS	Mean Square	F Value	Pr > F
Section	7	2486.419342	355.202763	20.10	<.0001
Dust	1	26.705805	26.705805	1.51	0.2231
Moisture	1	16.169123	16.169123	0.91	0.3421
Age	1	591.089166	591.089166	33.44	<.0001
Wind	1	9.399302	9.399302	0.53	0.4683

Parameter	Estimate	Standard Error	t Value	Pr > |t|
Average URCI Laramie vs Johnson	5.26596165	1.28732118	4.09	0.0001
Average URCI noRAP vs RAP	4.80737817	1.18336694	4.06	0.0001
Average URCI noCaCl vs CaCl	8.67047145	1.60173674	5.41	<.0001

Parameter	**Estimate**		**Standard Error**	**t Value**	**Pr > |t|**
Intercept	102.0479995	B	2.22689771	45.83	<.0001
Section A0	4.6065644	B	2.11742462	2.18	0.0330
Section A1	-2.1220789	B	1.88501433	-1.13	0.2641
Section A2	-11.3945134	B	1.92136966	-5.93	<.0001
Section P0	6.3220059	B	2.21834442	2.85	0.0057
Section P1	-3.1984453	B	1.88878748	-1.69	0.0948
Section S0	-11.3108234	B	2.26424636	-5.00	<.0001

Parameter	Estimate		Standard Error	t Value	Pr > |t|
Section S1	-7.9589419	B	2.29688627	-3.47	0.0009
Section S2	0.0000000	B	.	.	.
Dust	1.5379255		1.25113650	1.23	0.2231
Moisture	-0.7106810		0.74302542	-0.96	0.3421
Age	-0.1239219		0.02142860	-5.78	<.0001
Wind	-0.1010580		0.13857820	-0.73	0.4683

Note: The X'X matrix has been found to be singular, and a generalized inverse was used to solve the normal equations. Terms whose estimates are followed by the letter 'B' are not uniquely estimable.