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Sand/Gravel, Gypsum, and Iron Resources on the Wind River Indian Reservation, Wyoming

by Joseph Gersic and Lewis G. Nonini

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Prepared under the authority of Resolution No. 5271 of the Joint Business Council of the Shoshone and Arapahoe Tribes, Wind River Indian Reservation, Wyoming, dated March 16, 1983; and Interagency Agreement No. 30 between the Bureau of Indian Affairs and the Bureau of Mines.

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by

Joseph Gersic[1] and L. G. Nonini[1]

ABSTRACT

A reconnaissance study and sampling of sand and gravel deposits were conducted on the tribally owned portion of the reservation. Sixteen deposits were selected for sampling on the basis of either their size and proximity to possible markets or their being representative of other aggregate sources of various geologic origins on the reservation. Four terrace deposits in the south-central part of the reservation have the best potential for development because the deposits may be suitable, with proper processing, for most uses and are closer to possible markets than other tribally owned deposits. Sand and gravel is common in this region, and anyone attempting to develop these deposits as a commercial operation competing in the local market would face stiff competition from established local commercial operations. Before an attempt is made to develop a large-scale commercial operation on any deposit, it is recommended that extensive physical and chemical tests be done on the deposit.

A reconnaissance survey was made of the extensive outcrops on the reservation of the massive gypsum bed in the basal part of the Gypsum Springs Formation. Chip samples were taken across the massive gypsum bed at eight localities. Chemical tests performed on these surface samples indicate that they meet or exceed the criteria of purity for commercially acceptable gypsum. In five areas on the reservation, relatively small amounts of overburden overlie apparently large gypsum resources that should be readily minable using conventional surface mining techniques. The extent of gypsum can be mapped from outcrops, but drilling is necessary to determine gypsum reserves. Although gypsum apparently is abundant, should be readily minable in places, and appears to be pure enough for commercial use, high transportation costs from possible mine locations on the reservation to potential markets and competition from well established, vertically integrated companies (these companies not only mine and mill the crude gypsum but they also manufacture and sell finished products) probably would prevent its development in the near future.

[1]Physical Scientist, Intermountain Field Operations Center, Bureau of Mines, U. S. Department of the Interior, Denver, CO.

Two iron deposits have been reported on the reservation and several other iron deposits occur within 30 miles of the reservation boundary. The iron deposits on the reservation are small, scientifically interesting occurrences, but they have no potential as commercial sources of iron. In fact, none of the known iron deposits in Wyoming, including those on or near the Wind River Indian Reservation, can be considered economically minable unless market conditions in the severely depressed domestic steel industry improve dramatically.

INTRODUCTION

This report was prepared by the Bureau of Mines (Bureau) for the Bureau of Indian Affairs (BIA) under interagency agreement to investigate the potential for economic development of mineral resources on certain Indian lands. This report is the latest in series No. 8 of BIA administrative reports on various mineral resources on the Wind River Indian Reservation (figure 1). Resolution No. 5271 of the Shoshone and Arapahoe Tribes, Wind River Indian Reservation, Fort Washakie, Wyoming, requested that Mineral Phase Studies for FY 1984 include sand and gravel, gypsum, and iron ore. These three commodities are evaluated in this report.

Previous Investigations

Numerous published and unpublished reports have been written about the geology, structure, and mineral resources on or near the Wind River Indian Reservation. Because this report is concerned with sand and gravel, gypsum, and iron resources on the reservation, the papers listed in this section deal primarily with one or more of these resources.

Bolmer and Biggs (9)[1] and Seeland and Brauch (33) inventoried and evaluated the economic potential of mineral resurces on the reservation, including sand and gravel. The authors are aware of only one other report that discusses sand and gravel deposits on the reservation; this report by McGreevy and others (26) contains a geologic map of the reservation and a brief discussion of terrace, pediment, slope wash, flood plain, and related alluvial deposits of Quaternary age.

The presence of gypsum in the vicinity of the reservation was first reported by Endlich in 1877 (14). Since that time, the gypsum deposits have been studied and described repeatedly (9, 16-17, 20-24, 28, and 36). The report by Bolmer and Biggs (9) contains both a chemical analysis of a sample from the Maverick Spring anticline and an estimate of minable gypsum reserves in that area.

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[1]Underlined numbers in parentheses refer to items in the list of references preceding the appendixes at the end of this report.

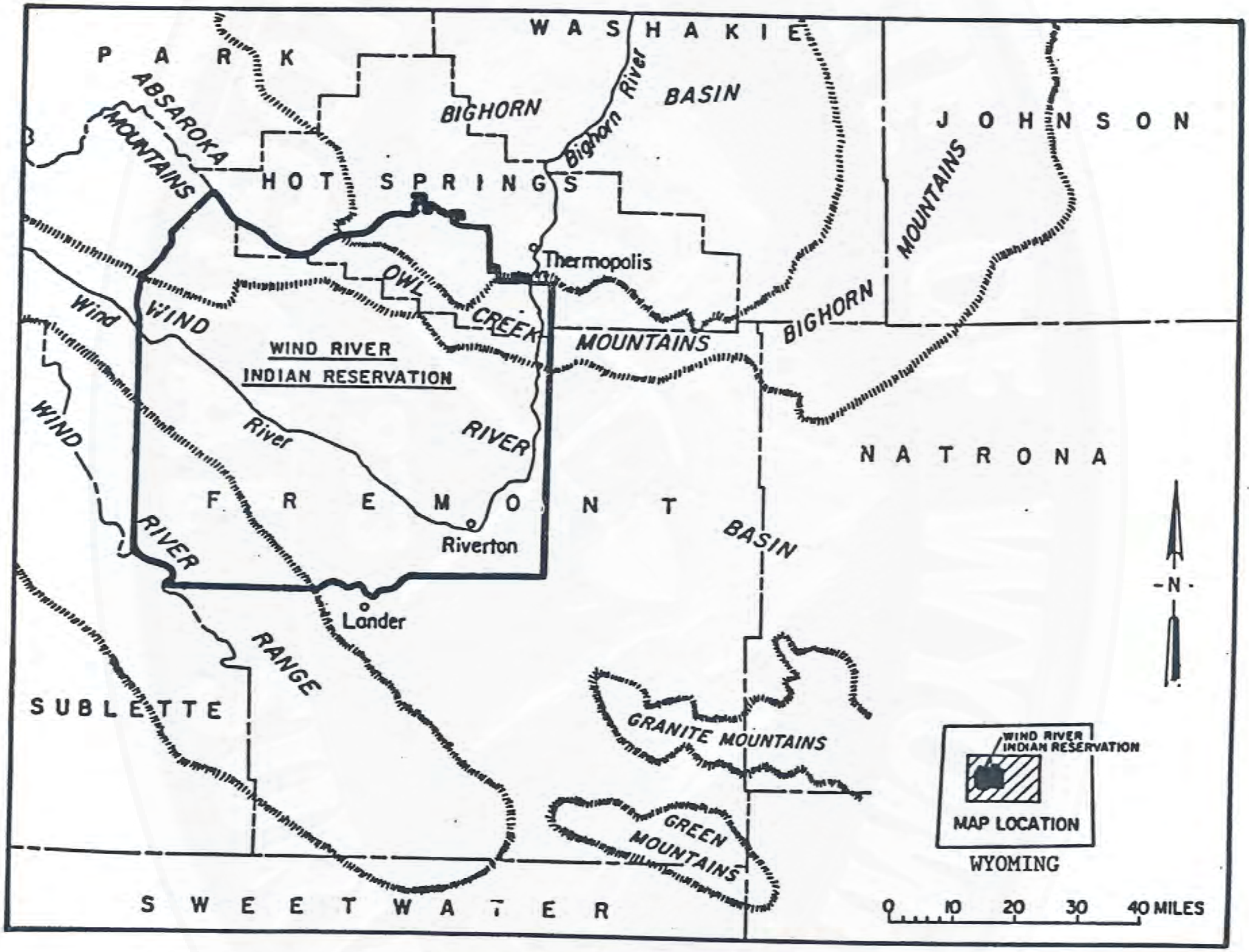

FIGURE 1. - Location of the Wind River Indian Reservation and physiographic features of west-central Wyoming.

Reports of iron occurrences in this area also date back to Endlich (14). Spencer (34) and Bayley (4-5) did intensive studies of the iron deposits in the Atlantic City--South Pass area. Other occurrences in the Wind River Range were described by Harrer (18), Worl (40), and Ryan (31). Harrer (18) and Bolmer and Biggs (9) described and analyzed the iron deposits east of the reservation in the Owl Creek Mountains. Love (25) and Biggs (8) identified the iron occurrences currently known on the reservation.

Present Investigation

The three commodities being studied were assigned priority on the basis of their potential usefulness to the tribes. Sand and gravel is considered as having the best potential for development; gypsum may have some potential; and iron has almost no potential for development. This prioritization is reflected in the amount and type of work done on each commodity.

Numerous sand and gravel deposits on the reservation were inspected by the Bureau field crew during the 1984 field season. Sixteen bulk samples collected from material excavated from backhoe pits dug in selected deposits were analyzed at the laboratory of Inberg-Miller Engineers in Riverton, Wyoming.

A reconnaissance was made of many gypsum outcrops on the reservation. Gypsum outcrops were measured at several sites, and discontinuous chip samples were taken across the outcrops at eight localities. The samples were analyzed for purity at Skyline Labs, Inc., Wheat Ridge, Colorado, using standard methods prescribed by the American Society for Testing and Materials (ASTM).

Iron occurrences in this region of Wyoming have been extensively studied. Little, if any, new information could be added to the existing data. Because of the present and foreseeable economic condition of the steel industry in the United States, much of the interest in discovering and developing new iron deposits has waned.

ACKNOWLEDGMENTS

The authors gratefully acknowledge the assistance provided by W. L. Collier, Superintendent of the BIA Wind River Indian Agency at Fort Washakie, WY, and members of his staff, particularly Arthur Hallett and Tony Aragon of the Department of Roads. Smokey Deshaw and Merton Trosper did an excellent job of digging the backhoe pits and and restoring the sites in selected sand and gravel deposits, and they also were helpful in bagging and loading the bulk samples. Donna Boyle and Dick Brohl of the U. S. Bureau of Reclamation office in Riverton were kind enough to provide storage space at their facility for the bulk samples.

SAND AND GRAVEL

A reconnaissance of the sand and gravel deposits of the Wind River Indian Reservation was made, and, in addition, samples were collected at 16 localities (plate 1). Deposits sampled were selected on the basis of either their size and proximity to potential markets or their being representative of other potential aggregate sources of various geologic origins on the reservation. Physical characteristics of the material in the deposits were observed in the pits and were recorded in field notes. Data that the authors believe are useful in evaluating the sand and gravel deposits on the reservation were extracted from field notes and placed in appendix A. Estimates of the volume of the selected deposits were made using data in the field notes. Bulk samples, ranging in weight from about 600 to 800 pounds, were collected from the material excavated at each test pit. These bulk samples were analyzed at the laboratory of Inberg-Miller Engineers in Riverton, Wyoming, using standard methods prescribed by the American Society for Testing and Materials (ASTM).

This report is not an in-depth study of all potential aggregate sources on the reservation. In order to evaluate any deposit completely, many trenches would have to be dug and samples from these trenches would have to be tested. Such a study would require much larger amounts of time and money than were allotted for this study.

Background Data

The sand and gravel industry is large and complex, and a detailed discussion of the entire industry is well beyond the scope of this report. For comprehensive discussions of the sand and gravel industry, the reader is referred to Dunn (13), Goldman (15), and Tepordei (37). The Concrete Manual (39) by the U. S. Bureau of Reclamation also is a good source of information.

Production of sand and gravel is the largest nonfuel mineral industry in the United States (15). Ninety-seven percent of the sand and gravel produced is consumed by the construction industry and the remainder goes into specialized products--such as glass--which require industrial sands that meet more rigid specifications. Within the construction industry, highway and road building consume the largest part of the production; building construction is the second largest consumer of sand and gravel; and the remainder goes into construction-related uses, such as fill, foundation stabilization, and septic fields. In the highway and road building industry, sand and gravel is used as aggregate both in asphaltic mixtures and in portland cement concrete, and it is used without a binder for road base and fill. In building construction, sand and gravel is used mainly as aggregate in portland cement concrete for use in both cast-in-place and precast structural and cladding elements.

Aggregate is the inert sand and gravel material that is transformed into a conglomeratic mass by a cementing substance such as portland cement, asphalt, or gypsum plaster (15). Commercially, sand may be defined as naturally occurring unconsolidated or poorly consolidated rock or mineral fragments ranging in size from about 0.003 to 0.187 inch; gravel is naturally occurring unconsolidated or poorly consolidated rock or mineral fragments ranging in size from about 0.188 to 3.5 inches (37). Sand has a wider range of uses than gravel. In a deposit, rock or mineral materials smaller than 0.003 inch or larger than 3.5 inches may cause special handling problems and do not qualify as sand and gravel.

Evaluation Methods

In general, four criteria are of interest to potential producers of sand and gravel (15): (1) quality of material, (2) size of deposit, (3) closeness to market, and (4) socioeconomic and legal restrictions on a potential mining operation. The first two criteria are important to both noncommercial and commercial producers because without the required quality and quantity the other criteria do not matter. The last two criteria are more important to potential commercial producers because of the effects they can have on mining and marketing costs. This study deals with the first three criteria and not with the last criterium. Socioeconomic and legal restrictions on development of sand and gravel deposits on tribal lands should be dealt with by the tribes and the BIA personnel at Fort Washakie. Ultimately, end-use for sand and gravel determines the amount, size, rock type, and chemical composition of an acceptable deposit (15).

Preliminary estimates of the quality and size of deposits generally are made by geologists or mining engineers working in the field. During a preliminary investigation (such as this study), potential sources of aggregate are examined to determine rock types and their physical conditions, including grading, rounding, sorting, size, and shape of particles. The degree of weathering of materials and the presence of any obviously deleterious substances are noted. The locations of deposits and routes to them are determined. The type and thickness of overburden and level of ground water are observed for each deposit. Also, and most important, samples are collected so that standard laboratory tests can be performed.

Quality specifications for sand and gravel depend upon end-use, specifying agency, and material availability. Commercial users, government agencies, and the American Society for Testing and Materials (ASTM) all have specifications for testing sand and gravel (table B1 in appendix B). Usually, the areas of concern in specifications are (13): (1) reaction of aggregates to alternate cycles of freezing and thawing or wetting and drying, both with and without salts present; (2) resistance to abrasion and impact; (3) particle shape; (4) gradation of materials;

and (5) deleterious constituents. Eleven ASTM standard test methods (2) (table B2 in appendix B) were used on the sand and gravel samples collected by the Bureau from deposits on the Wind River Indian Reservation. Results of the laboratory tests are shown in table B3, table B4, and the engineering reports in appendix B.

The quantity of sand and gravel in a deposit is important primarily when it is too small. Deposits must be large enough to satisfy the requirements for specific tasks, such as dam construction or road building, or they must be large enough to justify development where the material is sold on the open market.

Because sand and gravel is a low-unit-value, high-volume commodity, a commercial producer has to be concerned with transportation costs. If sand and gravel is transported far, transportation costs will equal or exceed market value. The average free-on-board plant prices in 1979 for three types of gravel were (37): (1) $2.59 per ton for building gravel; (2) $2.65 per ton for paving gravel; and (3) $1.55 per ton for fill gravel. Ninety percent of transportation of sand and gravel is by truck, and the average cost per ton is about $0.10 to $0.15 for each mile hauled (15). A 30-mile haul at $0.10 a ton-mile would increase the price of aggregate by $3 per ton. Even noncommercial producers, such as the BIA or the tribes, would have to consider transportation costs carefully before attempting to develop the more remote sand and gravel deposits on the reservation, particularly when the competition from established local commercial operations is considered.

The Annual Report for 1983 of the State Inspector of Mines of Wyoming (41) listed six commercial sand and gravel operations in Fremont County. They employed a total of 34 people and had a combined yearly production of 279,526 tons. Hot Springs County had one commercial sand and gravel operation (2 pits) employing 10 people and producing 20,022 tons. Most of these operations produced from pits close to their primary markets in Lander, Riverton, or Thermopolis. Because there are so many potential aggregate sources on nontribal lands in this area, the most likely users of tribal sand and gravel resources would be the Department of Roads of the BIA or the tribes.

Reservation Deposits

Sand and gravel deposits are abundant on the Wind River Indian Reservation. The larger deposits are either stream channel, flood plain, terrace, glacial moraine, or glacial outwash. A few small alluvial fan and windblown dune deposits are also present. Most of the stream channel and flood plain deposits are on privately owned land; and the dunes are small, scattered deposits, more of scenic or academic interest than of commercial value.

Bureau of Mines personnel collected 16 samples, principally from terrace deposits but also from glacial moraine, glacial outwash, and probable alluvial fan deposits on tribally owned land (appendix A and plate 1). The U. S. Bureau of Reclamation made available copies of tests done on aggregate sources primarily inside the Riverton Reclamation Withdrawal area. Most of these deposits are not on tribally owned land, but copies of 25 of the test reports are in appendix C and can be used for comparison with test results obtained on the samples collected by the Bureau.

Terrace and Related Deposits

Terrace deposits are remnants of old flood plain deposits that form benchlike structures along drainages but lie above the level of the present flood plain. Terrace deposits may be more desirable than stream channel or flood plain deposits because generally there are fewer problems with ground water in terrace deposits (15). Terrace deposits may contain materials similar to stream channel deposits, but weathering processes can produce some deleterious products in them, such as clays or free mica, which probably would not be present in stream channel deposits. In dry climates, precipitation leaches calcium carbonate out of the materials and produces caliche, which is sand and gravel cemented by porous calcium carbonate. Caliche is an undesirable substance common to most terrace deposits on the reservation.

On the reservation, true terrace deposits are quite common and widely distributed. Samples were taken from terraces at localities BM 1, 2, 5, 6, 7, 9, 11, 14, 15, and 16 (plate 1). With the exception of the sand and gravel sample taken near a diversion dam on the Wind River (BM 7), all the aggregates may be suitable, with proper treatment, for use as portland cement concrete aggregate, asphaltic concrete aggregate, or other less restrictive applications.

Deposits in some parts of the reservation have been mapped as terraces (26); but where the authors examined them, they did not appear to be true terraces. Some of these deposits are designated informally as pseudoterraces. Pseudoterraces are smaller and less common than true terraces, but their occurrence is still widespread. Pseudoterraces appear to result from weathering and erosion of the Wind River Formation and are regolithic caps on some buttes and mesas on the reservation. This type of deposit was sampled at locality BM 10, and several of the other deposits shown north of Crowheart Butte on plate 1 appear to be pseudoterraces. Test results for sample BM 10 indicate that the aggregate is not suitable for portland cement concrete or asphaltic concrete, but it may be suitable, with the proper treatment, for subbase and base material in road construction.

A deposit examined at locality BM 13, southwest of Fike's Ranch, has characteristics of an alluvial fan deposit instead of a terrace deposit. The deposit contains poorly sorted, subangular to well-rounded material in a wide distribution of sizes. Test results indicate that the aggregate is not suitable for any application.

Glacial and Fluvioglacial Deposits

Glacial deposits on the reservation are morainal material left behind by alpine glaciers. Moraines contain debris from everything that the glacier crossed. Rock debris in moraines cover the entire size spectrum from clay to boulders as large as houses. Because the moraines contain such a variety of materials in both size and composition, including an abundance of deleterious substances, they are generally poor sources of aggregate. Sample BM 12 came from a pit in morainal material north of Dinwoody Lake. Test results indicate that the material is not suitable for any application.

Fluvioglacial deposits generally are better sorted, contain less clay than purely glacial deposits, and may yield aggregates comparable in quality, if not quantity, to terrace, flood plain, or stream channel deposits. An outwash debris deposit, a type of fluvioglacial deposit, is characterized by great variation in particle size and by abrupt lateral and vertical change. Sample BM 8 came from an outwash plain near Bull Lake. Laboratory tests indicate that the aggregate may be suitable, with proper treatment, for use in asphaltic concrete and as subbase or base material in road construction. This deposit probably would not be developed because of the 8.5 feet of overburden. The terrace deposits examined at localities BM 3 and 4, west of Fort Washakie, appear to be more fluvioglacial in nature than true terrace deposits. Test results on the two deposits indicate that neither is suitable for any application.

Gold Content of Deposits

Many of the sand and gravel deposits on the Wind River Indian Reservation contain gold. Despite the widespread occurrence of gold, no deposits of commercial value have been found on the reservation (29, 32).

During this study, a one-cubic-foot sample of material was taken from each test pit to determine whether gold might be a valuable by-product of a sand and gravel operation. Each sample was panned down to a heavy sand concentrate in the field, and then the entire concentrate for each sample was fused in a laboratory using fire-assay techniques to produce a gold bead that was weighed. These techniques recover all the gold in each concentrate, including gold physically locked inside the heavy sands. As a result, the reported values are higher than any that could be obtained by normal placer mining methods. Skyline Labs, Inc., in Wheat Ridge, Colorado, performed the fire assays.

Assuming a value for gold of $350 per troy ounce, only 4 of the 16 samples contained values greater than $0.01 per cubic yard. As shown in table B5, the highest value obtained was $0.0335 per cubic yard. It is unlikely that gold in these amounts can be separated profitably from the gravels.

Conclusions and Recommendations

Terrace deposits sampled at localities BM 1, 2, 5, and 6 could be of more immediate value to the tribes than other deposits examined during this study. These deposits may be suitable after the proper processing for most uses, and they are closer to potential markets. Terrace deposits sampled at localities BM 9, 14, 15, and 16 might be valuable if someone were to do road building near these localities, but they are currently too far from other markets to be of commercial interest.

Before an attempt is made to develop a large-scale commercial sand and gravel operation on any deposit, it is recommended that a detailed examination of the deposit be made. A deposit under consideration should be studied in sufficient detail to compute an accurate volume, and enough bulk samples should be collected and analyzed to get a truly representative idea of the quality of the deposit.

GYPSUM

Gypsum-bearing formations crop out for more than 100 miles distance along the northeast flank of the Wind River Range, along both flanks of the Owl Creek Mountains, and along the flanks of the Lander-Hudson, Sage Creek, Maverick Spring, and Circle Ridge anticlines (plate 2). Large quantities of gypsum reportedly occur in the Chugwater (21) and Dinwoody Formations of Triassic age, but the Gypsum Springs Formation of Jurassic age contains the most extensive and potentially valuable gypsum resources in the area.

Background Data

Gypsum ($CaSO_4 \cdot 2H_2O$) is the most commonly occurring natural sulfate mineral and is found throughout the world in extensive, bedded deposits (30). Gypsum has been used by humans for several thousand years, and a worldwide mining and processing industry has been built round this multipurpose industrial mineral (3). At present, the three major areas of use are: (1) calcined gypsum used directly in construction or building materials, such as wallboard and plaster; (2) calcined gypsum used in the manufacturing or processing of other products, such as sanitary ware, pottery, metal castings, and decorative objects; and (3) uncalcined gypsum used in agricultural applications, such as soil conditioning or feed supplementing. Construction industries use about 70 percent of the gypsum consumed in the United States and account for approximately 94 percent of total product valuation; industrial applications use about 23 percent of the gypsum consumed, but only account for 5 to 6 percent of total product valuation; and agriculture uses the remaining 7 percent of the gypsum consumed in this country and contributes less than 1 percent to the total product valuation (3).

The gypsum industry is well developed in the United States, Canada, Western Europe, and Japan. In these areas, it is controlled mainly by large, well-financed, vertically integrated companies. Some companies are completely integrated from mining through marketing and distributing finished products. As a result of the vertical integration, practically no market exists for selling crude gypsum to the large calcining-manufacturing companies.

Evaluation Methods

Gypsum is a commodity of low unit value because it is plentiful, is generally easy to mine, is relatively simple to prepare for marketing, and must compete with other low-priced materials in the marketplace (3). Because of the variable nature of the market for which the gypsum is competing, no universal market price exists and each deposit must be evaluated against the competition within the region that it would serve. Thus, factors affecting marketing must be evaluated early during the feasibility study of a gypsum deposit.

Several factors must be considered during an evaluation of a gypsum deposit, but the most important factor is its location with respect to markets, that is its "place value." Deposits near a local market, even though they may be less pure or more difficult to mine than more remote deposits, may be considered more valuable (3). Frequently, the cost of transportation from a mine to major markets is the factor determining whether a gypsum deposit is developed.

Other factors influencing possible development are: (1) overburden ratios for surface mining, or roof conditions for underground mining; (2) thickness and lateral continuity of the deposit (tonnage); (3) grade of the deposit (types and amounts of impurities); (4) structural features; and (5) unusual groundwater conditions. The gypsum content of the deposit being evaluated generally should equal or exceed that of other deposits in the market area. Capital investment and operating costs for a mining operation are based on the parameters listed above and, in turn, these costs help determine overall production costs. Estimated production costs for a proposed gypsum mine must be low if the property is to be considered seriously for development.

Most commercial deposits range in gypsum content from 85 to 90 percent (3); deposits containing 80 percent gypsum are considered somewhat impure, whereas those containing 95 percent gypsum are exceptionally pure. The types of impurities, the end-use for the gypsum, and the market situation dictate the amounts of impurities that can be tolerated (3).

Appleyard (3, p. 779) separated impurities into three categories on the basis of the effect they may have on the manufacturing processes and finished products:

"1) Insoluble or relatively insoluble minerals such as limestone, dolomite, anhydrite, anhydrous clays, silica minerals, etc.

"2) Soluble chloride minerals such as halite, sylvite, etc.

"3) Hydrous minerals such as the sulfate salts mirabilite and epsomite, and the montmorillonite group of clays."

Because insoluble minerals (1 above) displace gypsum, they reduce the strength of rehydrated stucco and increase weights of plaster or wallboard required to obtain a given strength. Generally, as much as 10 to 15 percent of a crude gypsum may be insoluble minerals and the gypsum still will be considered acceptable for most commercial uses. Soluble chloride minerals (2 above) affect both calcining temperatures and the consistency and set time of stucco slurries. No more than 0.03 percent of a commercially valuable crude gypsum should be soluble chlorides. Hydrous minerals (3 above) affect both the moisture pickup of a finished product and the bonding characteristics between the paper and stucco core of wallboard. The maximum allowable content of hydrous sulfate salts in crude gypsum is 0.03 percent; however, a hydrous-clays content as large as 2 percent is considered acceptable.

Gypsum has been mined in Wyoming intermittently since 1890 (28); however, in the past few years, only three operations have been reported as active (19, 35). The Celotex Corp., which has a plant near Cody in Park County, is the largest producer in Wyoming; the Celotex Corp. plant receives crude gypsum from the Pat O'Hara Co. quarry. The Georgia Pacific Corp., whose mine and plant is northwest of Greybull in Big Horn County, is the second largest producer. The primary product at the Celotex Corp. and the Georgia Pacific Corp. plants is wallboard. Recent fluctuations in production at these operations reflect changes in the housing industry. The smallest gypsum producer is the Wyoming Construction Co., which supplies crude gypsum to the Monolith Plant in Laramie for use as an additive in making cement. The Wyoming Construction Co. mines gypsum at its Red Mountain quarry in Albany County. A summary of gypsum production data for the years 1979-83 is given in table 1.

Past attempts to mine gypsum on or near the reservation have met with varying degrees of success. Jamison (20) reported that a plaster plant was built in 1911 along Sage Creek near Fort Washakie, but there was no production. Harrer (17) reported that as late as 1920, gypsum was quarried 2.5 miles northeast of Lander and processed into plaster. In 1949, the Soil Sulphaid Distributing Co. of Thermopolis produced 3,015 tons of gypsum associated with sulfur from hot springs deposits 2.5 miles west of Thermopolis (28); however, the company shut down in 1950.

TABLE 1. - Gypsum production in Wyoming, 1979-83[1]

Year	Quantity, tons	Value	Average value per ton
1979	366,000	$3,100,000	$8.47
1980	312,000	2,731,000	8.75
1981	299,000	2,625,000	8.78
1982	283,000	2,963,000	9.91
1983	382,000	2,963,000	7.76

[1]Data from U.S. Bureau of Mines Minerals Yearbooks 1980-82 and from oral communication with Karl Starch, State Liaison Officer, Bureau of Mines, Denver, CO.

TABLE 2. - Thickness of massive gypsum bed at eight sample localities on the Wind River Indian Reservation, Wyoming

Sample	Locality	Measured thickness, ft	Computed true thickness, ft[1]
GYP 1	SE1/4 sec 13, T 2 S, R 1 E, WRM	65	64
GYP 2	NE1/4 sec 16, T 2 S, R 1 W, WRM	77	64
GYP 3	NW1/4 sec 31, T 1 S, R 1 W, WRM	77	75
GYP 4	SW1/4 sec 6, T 1 S, R 1 E, WRM	164	87
GYP 5	NE1/4 sec 20, T 1 N, R 1 W, WRM	64	58
GYP 6	SW1/4 sec 23, T 6 N, R 2 W, WRM	68	62
GYP 7	SW1/4 sec 18, T 7 N, R 1 W, WRM	85	85
GYP 8	SW1/4 sec 5, T 7 N, R 4 E, WRM	217	82

[1]Rounded to the nearest foot.

Reservation Deposits

On the reservation, the Gypsum Springs Formation contains in its basal part a massive bed of gypsum that, where present, ranges from about 35 to 90 feet in thickness. The massive gypsum generally contains a few thin lenses of mud, clay, or silt. In some areas, however, such as the southern end of the Sage Creek anticline, at Maverick Spring Dome, along Sagwup Draw, and in the Sweetwater Basin, thinner lenses of gypsum a few feet thick overlie the massive gypsum and are separated from it by beds of mudstone, siltstone, and calcareous shale several feet thick. In such areas, the total thickness of gypsum exceeds 100 feet. In other areas, the massive gypsum bed is greatly reduced in thickness and grades both laterally and vertically into material suggestive of turbidite.

During the reconnaissance of the gypsum outcrops, discontinuous chip samples were taken across the exposed width of the massive gypsum bed at eight localties (plate 2 and table 2). The samples were chemically analyzed to determine purity (tables 3 and 4)(1). The gypsum content ranges from 86.5 to 92.2 percent; anhydrite is the most abundant impurity, ranging from 4.4 to 6.8 percent (Skyline Labs, Inc., Wheat Ridge, Colorado, did the chemical analyses). As a whole, the surface samples meet or exceed the criteria of purity for a commercially acceptable gypsum, as specified earlier in this report.

In at least five areas on the reservation, relatively small amounts of overburden cover what appear to be large gypsum resources that should be readily minable using conventional surface mining techniques. The five areas in order of their proximity to the nearest railroad by the best existing routes are: (1) the Sweetwater Basin (secs 4-9, T 7 N, R 4 E, WRM); (2) the southeast end of the Sage Creek anticline (sec 6, T 1 S, R 1 E, WRM); (3) the central part of Maverick Spring anticline (secs 25, 26, and 36, T 6 N, R 2 W, WRM); (4) the ridge just northwest of the Bradford Ranch (secs 29 and 32, T 7 N, R 1 E, WRM); and (5) the ridge between Antelope Basin and Sagwup Draw (secs 19, 20, 29, and 30, T 7 N, R 1 W, WRM). Before the gypsum in any of the five areas is considered for development, however, a comprehensive exploration program should be undertaken.

Conclusions and Recommendations

The extent of gypsum can be mapped from outcrops, but drilling is necessary to determine gypsum reserves (3). Core drilling, generally with 1-5/8 inch diameter (BX) or larger core size, is the only way to recover gypsum samples that can be analyzed adequately for purity. Rotary drilling may be used if the only data desired are depth of overburden and location of the contact between gypsum and anhydrite.

TABLE 3. - Chemical analyses[1] of gypsum samples from the Wind River Indian Reservation, Wyoming

Sample No.	Free H_2O, pct	Comb. H_2O, pct	CO_2, pct	SiO_2 and insol., pct	Fe_2O_3, pct	Al_2O_3, pct	CaO, pct	MgO, pct	SO_3, pct	NaCl, pct
Gyp 1	<0.1	19.3	0.4	0.62	0.02	0.04	32.0	0.16	45.8	<0.04
Gyp 2	< .1	19.1	.6	.39	.01	.04	31.8	.37	45.3	< .04
Gyp 3	< .1	18.8	.8	.26	.02	.03	31.1	.72	44.5	< .04
Gyp 4	< .1	19.3	.5	.31	<.01	.02	31.7	.30	45.7	< .04
Gyp 5	< .1	19.3	.7	.32	.01	.01	31.8	.14	45.9	< .04
Gyp 6	.4	18.1	1.1	.62	.07	.16	31.7	.87	44.2	< .04
Gyp 7	4.3	18.9	.9	.53	.01	.02	31.7	.38	45.1	< .04
Gyp 8	< .1	18.5	1.1	.63	.02	.06	31.7	.92	43.7	< .04

Free H_2O = free water; pct = percent; Comb. H_2O = combined water; CO_2 = carbon dioxide; SiO_2 and insol. = silicon dioxide and insoluble matter; Fe_2O_3 = iron oxide; Al_2O_3 = aluminum oxide; CaO = calcium oxide (lime); MgO = magnesium oxide; SO_3 = sulfur trioxide; NaCl = sodium chloride.

[1]Methods used are those specified in the 1980 Annual Book of ASTM Standards, Part 13, C 471-76--Standard Methods for Chemical Analysis of Gypsum and Gypsum Products.

TABLE 4. - Recalculated[1] chemical analyses of the gypsum samples from the Wind River Indian Reservation, Wyoming

Sample No.	Gypsum, pct	Anhydrite, pct	SiO_2 and insol., pct	R_2O_3, pct	$CaCO_3$, pct	$MgCO_3$, pct	NaCl, pct
Gyp 1	92.2	4.9	0.62	0.06	<0.1	0.34	<0.04
Gyp 2	91.3	4.9	.39	.05	.2	.77	< .04
Gyp 3	89.8	4.6	.26	.05	< .1	1.50	< .04
Gyp 4	92.2	4.8	.31	.01	< .1	.63	< .04
Gyp 5	92.2	5.1	.32	.02	< .1	.29	< .04
Gyp 6	86.5	6.8	.62	.23	1.2	1.80	< .04
Gyp 7	90.3	5.3	.53	.03	.2	.79	< .04
Gyp 8	88.4	4.4	.63	.08	2.0	1.90	< .04

pct = percent; SiO_2 and insol. = silicon dioxide and insoluble matter; R_2O_3 = iron and aluminum oxide; $CaCO_3$ = calcium carbonate; $MgCO_3$ = magnesium carbonate; NaCl = sodium chloride.

[1]Results are recalculated to increase clarity. Methods used are those specified in the 1980 Annual Book of ASTM Standards, Part 13, C 471-76 --Standard Methods for Chemical Analysis of Gypsum and Gypsum Products, Section 14.

Even though the gypsum apparently is abundant, should be readily minable in a few areas, and appears to be pure enough for commercial use, there are two primary arguments against its development in the near future. Transportation costs from mines on the reservation to potential markets would be extremely high because the crude gypsum or calcined-gypsum products (if a plant were built on the reservation) would have to be shipped for long distances either by truck or by a combination of truck and rail. Also, the market for crude gypsum is small and the market for calcined-gypsum products is effectively controlled by large, well established companies that are already battling for a share of the business provided by the somewhat tenuous housing industry. Even if the tribes themselves decided to develop the gypsum resources and to manufacture finished products, it would be extremely difficult to compete effectively with the established companies under the present and probable near-future market conditions.

IRON

Two iron deposits have been reported on the reservation and several other iron deposits occur within 30 miles of the reservation boundary (plate 3). The term "deposit" is used here to mean a concentration of iron minerals, but it is not intended to imply ore in sufficient quantity and grade to invite commercial development.

Occurrences On or Near the Reservation

Hematitic granite that reportedly has a maximum iron content of 60 percent crops out through shale in the SE1/4 NW1/4 sec 15, T 7 N, R 5 W, Wind River Meridian (25). According to Love (25, p. 5), the deposit appears to be a dike and "* * * probably covers a considerable area." The deposit is very remote (more than 60 miles from the nearest railhead) and it probably is not large enough to be commercially developed as a source of iron even if it were less remote.

Pisolitic or oolitic hematite deposits, which occur in exposures of the Amsden Formation along the northeast flank of the Wind River Range, were described by Biggs (8) in his unpublished M. A. thesis in 1951 and by Harrer (18) in a Bureau information circular in 1966. Along the north side of the canyon of the North Fork of the Popo Agie (SE1/4 sec 5, T 33 N, R 101 W, Sixth Principal Meridian), two distinct beds of pisolitic hematite about 2 feet thick crop out at the top of a mottled red and yellow shale unit (8). Inside the reservation near the head of Pevah Creek (NE1/4 sec 28, T 1 N, R 3 W, WRM), Biggs measured 3.2 feet of red pisolitic hematite at some places; however, at other places, there are only two thin stringers of hematite separated by a thin, yellow shale. Biggs also stated that the pisolitic hematite unit is not present in sections that he measured at Bull Lake Creek, Meadow Creek, Dinwoody Creek, and Blue Holes Creek. Harrer (18) described an oolitic hematite unit as much as 7 feet thick in an iron-rich, red, marly limestone along

Red Creek just outside the west boundary of the reservation (secs 32 and 33, T 40 N, R 105 W, SPM). Individual samples, taken by the Bureau over 2- to 12-foot widths across this unit in the Red Creek drainage, range from 2.4 to 19.6 percent iron and a composite sample contained 13.3 percent iron (18). The pisolitic hematite deposits may be of scientific interest, but they are neither large enough nor of sufficient grade to be of commercial value.

Occurrences in the Wind River Range

Although several iron occurrences may be present in Precambrian rocks of the Wind River Range, only five iron deposits have been found that were considered significant enough to have been written about in detail. Listed from southeast to northwest, the deposits are: (1) Lewiston, (2) Atlantic City--South Pass, (3) Big Sandy and Little Sandy Creeks, (4) Downs Mountain, and (5) Wildcat Creek.

The Lewiston deposit is a 100-foot wide, metamorphic-banded-magnetite taconite[1] that is exposed for 600 feet along strike (18). The deposit is reportedly near Lewiston in sec 5, T 28 N, R 98 W, SPM, about 11 miles southeast of Atlantic City and about 32 miles south of the reservation. Supposedly, the iron deposit is too small to be mined commercially (18).

The magnetitic taconites around Atlantic City--South Pass (sec 19, T 30 N, R 99 W; and secs 13, 23-26, and 35, T 30 N, R 100 W, SPM) are the most intensely studied iron deposits in the area (4, 5, 18, and 34). The best known of these is the ore body in sec 26, T 30 N, R 100 W, SPM, that formerly was being mined at the Atlantic City Ore Operations of the U.S. Steel Corporation (4-5). Because of folding and complex faulting, the normally 140- to 160-foot-thick iron formation has an exposed width ranging from 300 to 1,200 feet for a distance of about 4,000 feet; thereby creating a more massive iron deposit than generally is found in the Wind River Range. In 1960, published tonnage and grade figures (27) for the Atlantic City Mine ore body were 300 million tons of indicated taconite resources assaying about 22 to 35 percent iron and 121.2 million tons of measured taconite reserves assaying between 28 and 32 percent iron. Atlantic City Ore Operations has ceased operating and will not reopen in the near future.

Very little information is available on the iron occurrences near the headwaters of Big Sandy and Little Sandy Creeks (Ts 29 to 31 N, Rs 103 to 105 W). In 1966, Harrer (18) said that iron-bearing schists had been reported in Precambrian metasediments in the Big Sandy Opening in Sublette County (vicinity of Dutch Joe and Big Sandy Creeks). Another report in 1966 (28, p. 118) stated, "Specular hematite is found 'in veins cutting granites of Wind River Range on the upper drainage of the Little Sandy.'" The Lander Quadrangle: Residual Intensity Magnetic Anomaly Contour Map (6) does indicate a rather strong anomaly in this area;

[1]Taconite may be defined as a fine-grained, cherty, jaspery, or siliceous, bedded to slatelike, iron-bearing rock.

however, the anomaly is not as intense as the anomalies shown around Iron Mountain or Cony Mountain in the Atlantic City district. Further investigation would have to be done in the area to establish whether it has any potential as a source of iron.

A Bureau mineral investigation of the Bridger Wilderness (31) revealed small pods of taconite in several parts of the wilderness; but, the pods generally are estimated to contain less than a few hundred tons of taconite. None of the identified taconite deposits are considered to be potential sources of iron in the foreseeable future because of their size and location.

Two iron occurrences in the Wind River Range--Downs Mountain and Wildcat Creek--are toward the northern end of the mountains. Worl (40) described the Downs Mountain taconite occurrence as one large and two small bodies in the south-central and west-central parts, respectively, of T 39 N, R 107 W, SPM. The larger taconite body is at an altitude of 11,000 feet, is in the Bridger Wilderness Area, is 25 miles by jeep trail from Dubois, and is at least 85 miles from the nearest railroad. Worl (40, p. 14) concluded that, "The taconite is of great academic interest but will never be of economic importance." Harrer (18) described the Wildcat Creek occurrence as a small, low-grade deposit of magnetite disseminated in a red, granitic pegmatoid (SE1/4 sec 3, T 41 N, R 108 W, SPM). The Wildcat Creek occurrence does not appear to have economic potential.

Occurrences in the Owl Creek Mountains

According to Harrer (18), a banded Precambrian iron formation can be traced for about 10 miles along the top of the eastern Owl Creek Mountains in the vicinity of Copper Mountain, which is about 10 miles due east of Boysen. The taconite is exposed at Birdseye Pass (sec 15, T 40 N, R 94 W, SPM), the head of Hoodoo Creek (secs 14, 15, 22, and 23, T 40 N, R 93 W, SPM), the head of Dry Creek (secs 13 and 14, T 40 N, R 93 W, SPM), and the McGraw Copper Mine (SW1/4 sec 7, T 40 N, R 92 W, SPM). The principal iron mineral is magnetite that, in places, has been partially oxidized to hematite and limonite. In 1966 Bolmer and Biggs (9) stated that low-volume, selective mining probably could have been done on individual lenses that are 30 to 40 feet thick and range from 25 to 30 percent iron; however, they also stipulated that large-scale mining of the lenses and material between the lenses (gangue) could not have been done under the then-existing economic and technologic conditions because the grade of the combined lenses and gangue only ranges from 15 to 17 percent iron. Under present conditions these deposits are not economically minable.

Although supposedly comparable Precambrian rocks are exposed inside the reservation along the crest of the Owl Creek Mountains, no evidence of similar iron occurrences were noted during this study. No reports were found that described any iron formations cropping out in the area. The Thermopolis Quadrangle: Residual Intensity Magnetic Anomaly Contour Map (7) does not show any high intensity anomalies there.

Gravimetric and Magnetic Data

In 1966, Case and Keefer (10) conducted a regional gravity survey of the Wind River Basin. The Bouguer gravity anomaly contour map in that report does not show a gravity anomaly inside the reservation comparable to the gravity anomaly around the Atlantic City iron mine.

The aeromagnetic maps of south-central Fremont County (11) and the northeast part of the reservation (12) do not show anomalies on the reservation that might be indicative of undiscovered iron deposits. The residual intensity magnetic anomaly contour maps for the Lander Quadrangle (6) and the Thermopolis Quadrangle (7) do not show anomalies indicative of potential iron deposits inside the reservation.

Conclusions

The domestic steel industry is severely depressed and it probably will remain depressed for some time. As a result, the demand for iron ore has dropped and the only two recently active iron mines in Wyoming, the Atlantic City Ore Operations of U.S. Steel Corp. and the Sunrise Mine of the Colorado Fuel and Iron Corp., have closed. It is probable that neither mine will reopen in the near future. None of the known iron deposits in Wyoming, including those on or near the Wind River Indian Reservation, can be considered economically minable unless market conditions improve dramatically.

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LIST OF ABBREVIATIONS AND SYMBOLS USED IN THIS REPORT[1]

ASTM	American Society for Testing and Materials
Fe	iron
ft	foot
in.	inch
mi	mile
mi^2	square mile
mg	milligram
oz	ounce
pct	percent
(Rc)	reduction in alkalinity
(Sc)	concentration of silica in original filtrate
SPM	Sixth Principal Meridian
WRM	Wind River Meridian
yd^3	cubic yard
>	greater than
"	inch
<	less than
<<	much less than
X 10^6	million
/	per
(%)	percent
(?)	uncertainty

[1]Does not include symbols and abbreviations used in the reports by the U. S. Bureau of Reclamation included in appendix C.

APPENDIX A.--

Data extracted from field notes on sand and gravel deposits on the Wind River Indian Reservation, Wyoming.

NOTE: Areas are estimated from outcrops shown on plate 1. Volumes are approximations of the mininum amounts of materials that could reasonably be expected to be in the deposits, and the volumes could, in fact, be considerably larger.

Sample: BM 1

Name and location of deposit: 17-mile disposal site
USGS topo sheet: Pavillion SE; SE1/4 sec 32, T 1 N, R 3 E, WRM

Type of deposit: terrace
Character of topography: top of large mesa
Description of vegetation: mostly sagebrush with sparse grass
Overburden: 2 ft of reddish-brown, silty soil

Primary features of deposit:
Estimated: thickness: > 12 ft; area: 4 mi^2; volume: 49 X 10^6 yd^3

Observed in test pit: at maximum extension of backhoe still in gravel
Degree of sorting and rounding: poor to moderate sorting; well-rounded pebbles and cobbles
Approximate percentage of material larger than maximum size included in sample: < 1 pct
Deleterious substances, if any: caliche encrustations in upper 10 ft of deposit
Ground-water level: none apparent

Sample: BM 2

Name and location of deposit: Kinnear Bridge
USGS topo sheet: Pavillion; NW1/4 sec 26, T 2 N, R 1 E, WRM

Type of deposit: terrace
Character of topography: edge of river-terrace remnant
Description of vegetation: clover, grass, sagebrush, and cactus
Overburden: 0.4 ft of light-brown, silty soil

Primary features of deposit:
Estimated: thickness: > 14 ft; area: 2 mi^2; volume: 29 X 10^6 yd^3

Observed in test pit: bottomed in gravel
Degree of sorting and rounding: poorly sorted; well rounded
Approximate percentage of material larger than maximum size included in sample: < 1 pct; largest boulder seen was 11 in. in longest dimension
Deleterious substances, if any: small amount of caliche encrustations; some free mica
Ground-water level: none apparent

Sample: BM 3

Name and location of deposit: Mocassin Lake Road
USGS topo sheet: Wind River; SE1/4 sec 11, T 1 S, R 2 W, WRM

Type of deposit: terrace(?); glacial outwash(?)
Character of topography: top of a large butte or small mesa
Description of vegetation: moderate amount of sagebrush and grass
Overburden: 1.5 ft of reddish-brown, silty soil

Primary features of deposit:
Estimated: thickness: > 12 ft; area: 0.6 mi^2; volume: 7 X 10^6 yd^3

Observed in test pit: bottomed in gravel
Degree of sorting and rounding: poorly sorted; moderate to well rounded
Approximate percentage of material larger than maximum size included in sample: 3 pct; largest boulder seen was 16 in. in longest dimension
Deleterious substances, if any: caliche encrustations in upper 4 ft of deposit
Ground-water level: none apparent

Sample: BM 4

Name and location of deposit: "North Fork Flat"
USGS topo sheet: Fort Washakie; SE1/4 sec 33, T 1 N, R 2 W, WRM

Type of deposit: terrace(?); glacial outwash(?)
Character of topography: small mesa
Description of vegetation: primarily grass with sparse sagebrush
Overburden: 1.5 ft of reddish-brown, silty soil

Primary features of deposit:
Estimated: thickness: > 9 ft; area: 1.2 mi^2; volume: 11 X 10^6 yd^3

Observed in test pit: stopped digging because of large boulder in pit
Degree of sorting and rounding: poor to moderate sorting; moderate to well rounded
Approximate percentage of material larger than maximum size included in sample: 10 pct; largest boulder measured 28 in. in longest dimension
Deleterious substances, if any: caliche encrustations; free mica
Ground-water level: none apparent

Sample: BM 5

Name and location of deposit: Bighorn Flat about 2 mi east of Hwy 287
USGS topo sheet: Argo Butte; SW1/4 sec 32, T 3 N, R 1 W, WRM

Type of deposit: terrace
Character of topography: large flat area
Description of vegetation: mainly sagebrush with sparse grass
Overburden: 2 ft of brown, clayey soil

Primary features of deposit:
Estimated: thickness: > 12 ft; area: 16 mi^2; volume: 198 X 10^6 yd^3

Observed in test pit: bottomed in gravel(same deposit as sample BM 6)
Degree of sorting and rounding: poor to moderate sorting; moderate to well rounded
Approximate percentage of material larger than maximum size included in sample: 1 pct; largest boulder seen was 16 in. in longest dimension
Deleterious substances, if any: caliche encrustations near surface
Ground-water level: none apparent

Sample: BM 6

Name and location of deposit: Bighorn Flat about 2.5 mi west of Hwy 287
USGS topo sheet: Bull Lake East; SW1/4 sec 4, T 2 N, R 2 W, WRM

Type of deposit: terrace
Character of topography: large flat area
Description of vegetation: mainly sagebrush with sparse grass
Overburden: 1.5 ft of dark-brown, silty soil

Primary features of deposit:
Estimated: thickness: > 12 ft; area: 16 mi^2; volume: 198 X 10^6 yd^3

Observed in test pit: bottomed in gravel(same deposit as sample BM 5)
Degree of sorting and rounding: poorly sorted; moderate to well rounded
Approximate percentage of material larger than maximum size included in sample: < 1 pct; largest boulder seen was 16 in. in longest dimension
Deleterious substances, if any: some caliche encrustations
Ground-water level: none apparent

Sample: BM 7

Name and location of deposit: "Diversion Dam"
USGS topo sheet: Argo Butte; SE1/4 sec 14, T 3 N, R 2 W, WRM

Type of deposit: terrace
Character of topography: flat area 100 ft above present river level
Description of vegetation: mainly grass and cactus with sagebrush
Overburden: 2 ft of dark-brown, silty soil

Primary features of deposit:
Estimated: thickness: 10 ft; area: 0.75 mi^2; volume: 8 X 10^6 yd^3

Observed in test pit: bottomed in sandy shale of Wind River Fm.
Degree of sorting and rounding: poorly sorted; moderately rounded
Approximate percentage of material larger than maximum size included in sample: 1 pct; largest boulder seen was 12 in. in longest dimension
Deleterious substances, if any: small amount of caliche encrustations; some free mica
Ground-water level: none apparent

Sample: BM 8

Name and location of deposit: Bull Lake Terrace
USGS topo sheet: Bull Lake East; NE1/4 sec 18, T 3 N, R 2 W, WRM

Type of deposit: glacial outwash
Character of topography: gently sloping plain
Description of vegetation: sagebrush, grass, and cactus
Overburden: 8.5 ft of light-brown, clayey silt with 10 pct pebbles and cobbles

Primary features of deposit:
Estimated: thickness: > 3.6 ft; area: 3.5 mi^2; volume: 11 X 10^6 yd^3

Observed in test pit: bottomed in gravel
Degree of sorting and rounding: poorly sorted; moderate to well rounded
Approximate percentage of material larger than maximum size included in sample: < 1 pct; largest boulder seen was 14 in. in longest dimension
Deleterious substances, if any: some free mica
Ground-water level: none apparent

Sample: BM 9

Name and location of deposit: "Landing Strip Flat"
USGS topo sheet: Crowheart Butte; SE1/4 sec 36, T 4 N, R 3 W, WRM

Type of deposit: terrace
Charcter of topography: flat river terrace remnant
Description of vegetation: sagebrush, grass, and cactus
Overburden: 3 ft of light-brown, silty siliceous soil

Primary features of deposit:
Estimated: thickness: > 10 ft; area: 1.2 mi^2; volume: 12 X 10^6 yd^3

Observed in test pit: bottomed in gravel
Degree of sorting and rounding: poorly sorted; moderate to well rounded
Approximate percentage of material larger than maximum size included in sample: < 1 pct; largest boulder seen was 8 in. in longest dimension
Deleterious substances, if any: caliche encrustations; small amount of free mica
Ground-water level: none apparent

Sample: BM 10

Name and location of deposit: "North Crowheart Overlook"
USGS topo sheet: Crowheart NE; SE1/4 sec 16, T 5 N, R 3 W, WRM

Type of deposit: "regolithic" terrace
Character of topography: small mesa
Description of vegetation: mostly grass with some sagebrush
Overburden: 1 ft of reddish-brown, sandy soil

Primary features of deposit:
Estimated: thickness: 6 ft; area: 0.4 mi^2; volume: 2 X 10^6 yd^3

Observed in test pit: bottomed in sandstone of Wind River Fm.
Degree of sorting and rounding: poorly sorted; moderately rounded
Approximate percentage of material larger than maximum size included in sample: 5 pct; largest boulder seen was 8 in. in longest dimension
Deleterious substances, if any: caliche encrustations
Ground-water level: none apparent

Sample: BM 11

Name and location of deposit: Dinwoody Canal
USGS topo sheet: Wilderness; S1/2 sec 15, T 5 N, R 5 W, WRM

Type of deposit: terrace(?); glacial outwash(?)
Character of topography: terrace (?) remnant about 300 ft above present river level
Description of vegetation: sagebrush, grass, and cactus
Overburden: 3.5 to 4 ft of reddish-brown, silty soil

Primary features of deposit:
Estimated: thickness: > 5 ft; area: 2.3 mi^2; volume: 14 X 10^6 yd^3

Observed in test pit: hit immovable boulder; did not dig deeper
Degree of sorting and rounding: poor sorting; moderate rounding
Approximate percentage of material larger than maximum size included in sample: 3 pct; largest boulder seen was more than 6 in. in longest dimension
Deleterious substances, if any: fine clay(?); free mica(?)
Ground-water level: none apparent

Sample: BM 12

Name and location of deposit: Dinwoody
USGS topo sheet: Wilderness; SE1/4 sec 8, T 5 N, R 5 W, WRM

Type of deposit: glacial moraine
Character of topography: hummocky
Description of vegetation: sagebrush, grass, and cactus
Overburden: < 1 ft of reddish, sandy soil

Primary features of deposit:
Estimated: thickness: > 13 ft; area: 9.5 mi^2; volume: 128 X 10^6 yd^3

Observed in test pit: bottomed in gravel
Degree of sorting and rounding: poor sorting; moderate rounding
Approximate percentage of material larger than maximum size included in sample: > 5 pct; largest boulder observed near the pit was more than 72 in. in the longest dimension
Deleterious substances, if any: minor amount of free mica
Ground-water level: none apparent

Sample: BM 13

Name and location of deposit: Southwest of Fike Ranch
USGS topo sheet: Circle Ridge; NE1/4 sec 10, T 6 N, R 3 W, WRM

Type of deposit: terrace(?); alluvial fan(?)
Character of topography: gently rolling plain
Description of vegetation: grass with sparse sagebrush
Overburden: 1 ft of reddish-brown, sandy soil

Primary features of deposit:
Estimated: thickness: > 13 ft; area: 0.6 mi^2; volume: 6×10^6 yd^3

Observed in test pit: bottomed in gravel
Degree of sorting and rounding: poorly sorted; subangular to well rounded
Approximate percentage of material larger than maximum size included in sample: > 5 pct; largest boulder seen was 16 in. in longest dimension
Deleterious substances, if any: chert, caliche, and free mica
Ground-water level: none apparent

Sample: BM 14

Name and location of deposit: Barquin Reservoir
USGS topo sheet: Maverick Spring; NW1/4 sec 16, T 6 N, R 1 W, WRM

Type of deposit: terrace
Character of topography: terrace remnant between drainages
Description of vegetation: mostly grass with sparse sagebrush and cactus
Overburden: 1.3 ft of light-brown, silty soil

Primary features of deposit:
Estimated: thickness: > 12 ft; area: 2 mi^2; volume: 19×10^6 yd^3

Observed in test pit: bottomed in gravel
Degree of sorting and rounding: poorly sorted; moderately rounded
Approximate percentage of material larger than maximum size included in sample: < 1 pct; largest rock seen was 8 in. in longest dimension
Deleterious substances, if any: none apparent
Ground-water level: none apparent

Sample: BM 15

Name and location of deposit: Muddy Creek One
USGS topo sheet: Harris Bridge; NW1/4 sec 36, T 5 N, R 2 E, WRM

Type of deposit: terrace
Character of topography: small mesa
Description of vegetation: mainly grass with sparse sagebrush and cactus
Overburden: 1 ft of medium-brown, silty soil

Primary features of deposit:
Estimated: thickness: 6.7 ft; area: 1 mi^2; volume: 6×10^6 yd^3

Observed in test pit: bottomed in sandstone of Wind River Fm.
Degree of sorting and rounding: poorly sorted; moderate to well rounded
Approximate percentage of material larger than maximum size included in sample: $\ll$ 1 pct; largest cobble seen was 6 in. in longest dimension
Deleterious substances, if any: minor amounts of caliche encrustations in upper 1 ft of gravel
Ground-water level: none apparent

Sample: BM 16

Name and location of deposit: Muddy Creek Two
USGS topo sheet: Harris Bridge; NW1/4 sec 32, T 5 N, R 3 E, WRM

Type of deposit: terrace
Character of topography: gently sloping top of large mesa
Description of vegetation: moderate grass with sparse sagebrush and cactus
Overburden: 1.5 ft of medium-brown, silty soil

Primary features of deposit:
Estimated: thickness: 9.5 ft; area: 9 mi^2; volume: 84×10^6 yd^3

Observed in test pit: bottomed in sandstone of Wind River Fm.
Degree of sorting and rounding: poor sorting; moderate rounding
Approximate percentage of material larger than maximum size included in sample: < 1 pct; largest boulder seen was 11 in. in longest dimension
Deleterious substances, if any: caliche in upper 3 ft of gravel
Ground-water level: none apparent

APPENDIX B.--

Data on testing and specifications for sand and gravel from deposits on the Wind River Indian Reservation, Wyoming, including results from 11 ASTM tests, assays for gold content, and engineering reports.

TABLE B1. - Minimum standards considered acceptable for most uses for aggregate from an untried source

Quality	Minimum standard[1]	ASTM reference test[2]
Abrasion	Abrasion loss less than 30 percent	C 131 C 535
Soundness	Sodium sulfate test less than 10 percent	C 88
Specific gravity	Should be greater than 2.55	C 127
Size and grading	(1) Fine aggregate should contain no more than 45 percent of the material between two consecutive sieve sizes; (2) fineness modulus should be between 2.3 and 3.1; and (3) no more than 5 percent of the material should pass the No. 200 sieve.	C 136 C 117 C 295
Reactivity	A mortar bar containing the aggregate should have an expansion less than 0.10 percent in one year with a 0.8 percent alkali content cement.	C 227 (C 289)[3]
Absorption	Absorption should not exceed 3 percent.	C 127 C 128
Durability	Concrete containing the aggregate should not have a loss in the modulus of elasticity exceeding 50 percent in the freeze-thaw test.	C 290 (C 88)
Sand equivalent	Fine aggregate should have a sand equivalent of not less than 75.	D 2419

[1] Compiled by H. B. Goldman from average basic requirements recommended by the ASTM, California Division of Highways, U.S. Army Corp of Engineers, and the U.S. Bureau of Reclamation. Sand and Gravel chapter in Industrial Minerals And Rocks (Nonmetallics Other Than Fuels) edited by S. J. Lefond and others. AIME, New York, NY, 5th ed., 1983, pp. 1151-1166.

[2] As specified in the Annual Book of the American Society for Testing and Materials (ASTM) Standards, Parts 14 and 19.

[3] ASTM reference tests listed in parentheses are tests that yield data about the specified quality in shorter time periods, such as a few weeks, rather than much longer periods, such as several months or years, required by the tests listed first.

TABLE B2. - Tests performed on 16 sand and gravel samples collected by the Bureau of Mines from deposits on the Wind River Indian Reservation, Wyoming

Standard test method[1]	ASTM reference number
Organic Impurities in Fine Aggregates for Concrete................	C 40
Soundness of Aggregates by Use of Sodium Sulfate or Magnesium Sulfate..	C 88
Materials Finer Than No. 200 Sieve in Mineral Aggregates by Washing..	C 117
Specific Gravity and Absorption of Coarse Aggregate................	C 127
Resistance to Abrasion of Small Size Coarse Aggregate by Use of the Los Angeles Machine......................................	C 131
Sieve Analysis of Fine and Coarse Aggregates......................	C 136
Potential Reactivity of Aggregates (Chemical Method)..............	C 289
Petrographic Examination of Aggregates for Concrete...............	C 295
Resistance to Abrasion of Large Size Coarse Aggregate by Use of the Los Angeles Machine......................................	C 535
Liquid Limit of Soils..	D 423
Plastic Limit and Plasticity Index of Soils......................	D 424

[1]As specified in the Annual Book of the American Society for Testing and Materials (ASTM) Standards, Parts 14 and 19.

TABLE B3. - Results of eight ASTM tests performed on sand and gravel samples from the Wind River Indian Reservation, Wyoming

BIA report number	Sample Number	ASTM D423 & D424	ASTM C127		ASTM C88 Sodium Sulfate Soundness Weighted Percentage Loss after 5 cycles (%)		Los Angeles Abrasion Test				ASTM C-289 Potential Reactivity			ASTM C40
			Coarse Aggreg.				Loss After 1000 Revolutions ASTM C535 Large Size Coarse Aggregate		Loss After 500 Revolutions ASTM C131 Small Size Coarse Aggregate		Millimoles /Liter			
		Plasticity Index	Bulk Specific Gravity	Absorption (%)	Coarse Aggregate retained on #4	Fine Aggregate Finer than 3/8"	Grading	Loss (%)	Grading	Loss (%)	Reduc. in Alk. (Rc)	Diss. Silica (Sc)	Reactivity	Organic Content
BM 1	1	Non-Plastic	2.53	1.6	2.6	9.1	3	21.1	B	20.4	130	300	Pot. Delet.	Insignificant
BM 3	2	Non-Plastic	2.49	2.6	12.3	11.5	"	37.7	"	38.3	135	14	Innocuous	Insignificant
BM 4	3	Non-Plastic	2.52	2.7	5.2	12.7	"	38.8	"	44.6	122	13	Innocuous	Insignificant
BM 5	4	Non-Plastic	2.55	1.7	5.4	9.5	"	24.9	"	22.2	195	270	Pot. Delet.	Insignificant
BM 6	5	Non-Plastic	2.51	2.0	11.2	7.9	"	23.0	"	24.2	118	295	Pot. Delet.	Insignificant
BM 7	6	Non-Plastic	2.54	1.7	9.3	18.7	"	21.3	"	21.5	208	240	Pot. Delet.	Insignificant
BM 9	7	Non-Plastic	2.52	1.8	5.1	8.5	"	26.1	"	22.4	131	620	Pot. Delet.	Insignificant
BM 12	8	Non-Plastic	2.51	2.6	11.0	10.5	"	39.3	"	52.6	135	58	Innocuous	Insignificant
BM 11	9	Non-Plastic	2.59	1.8	4.8	9.4	"	29.7	"	28.4	112	50	Innocuous	Insignificant
BM 8	10	Non-Plastic	2.55	1.2	3.2	11.2	"	15.2	"	20.4	175	230	Pot. Delet.	Insignificant
BM 13	11	Non-Plastic	2.44	2.9	16.1	12.8	"	36.4	"	30.3	192	255	Pot. Delet.	Insignificant
BM 10	12	Non-Plastic	2.65	1.8	9.4	15.4	"	17.6	"	29.0	88	25	Innocuous	Insignificant
BM 15	13	Non-Plastic	2.52	2.5	7.4	9.6	"	28.6	"	26.3	218	115	Innocuous	Insignificant
BM 16	14	Non-Plastic	2.55	1.3	5.1	8.9	"	32.7	"	29.0	160	40	Innocuous	Insignificant
BM 14	15	Non-Plastic	2.42	3.3	8.8	8.3	"	34.6	"	30.5	250	310	Pot. Delet.	Insignificant
BM 2	16	Non-Plastic	2.62	0.7	2.3	7.3	"	20.5	"	19.0	142	300	Pot. Delet.	Insignificant

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TABLE B4. - Test results of ASTM sieve analyses performed on sand and gravel samples from the Wind River Indian Reservation, Wyoming

BIA report number	BM 1	BM 3	BM 4	BM 5	BM 6	BM 7	BM 9	BM 12	BM 11	BM 8	BM 13	BM 10	BM 15	BM 16	BM 14	BM 2
Sample Number	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Sieve Size	PERCENT PASSING BY WEIGHT															
3½"	-	-	-	-	100	100	100	100	100	100	100	-	-	-	100	-
3"	-	-	-	-	93	91	96	92	94	90	91	-	-	-	94	-
2½"	100	100	100	100	-	-	-	-	-	-	-	100	100	100	-	100
2"	93	93	90	88	80	85	89	87	88	85	81	95	93	99	86	87
1½"	81	86	84	83	76	78	84	82	85	73	73	86	87	98	80	81
1"	69	77	78	73	66	70	77	79	80	63	65	74	81	95	73	68
3/4"	61	72	75	68	58	65	71	76	76	58	59	68	76	93	66	59
1/2"	52	66	71	60	51	57	62	73	71	50	52	61	68	89	57	47
3/8"	48	62	68	54	46	52	57	70	68	47	48	59	61	86	51	40
#4	41	50	61	45	38	42	50	62	60	39	39	54	48	76	37	30
#8	38	44	50	37	31	37	45	54	51	35	32	48	41	69	30	25
#16	35	35	37	31	25	32	40	44	42	31	27	39	36	62	23	22
#30	31	27	25	23	18	26	33	31	33	26	21	26	32	54	18	17
#50	21	19	15	12	11	19	19	18	24	18	15	15	28	41	14	7
#100	12	12	8	6	6	11	9	11	15	12	9	7	18	22	11	3
#200	6.9	6.3	4.4	3.4	3.2	6.2	5.3	6.5	9.5	8.1	5.4	4.2	9.3	10.5	6.9	1.1

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Riverton, Wyoming 82501

TABLE B5. - Gold values of selected sand and gravel deposits on the Wind River Indian Reservation, Wyoming

(Gold content determined by fire assay; assumed value for gold is $350/troy oz)

BIA report number	Field number	Amounts of material per cubic foot		Computed material per cubic yard		Gold value, cents/yd^3
		concentrate, grams	gold, mg	concentrate, grams	gold mg	
BM 1	1	19.25	0.1103	519.7	2.978	3.35
BM 3	2	31.51	0.0010	850.8	<0.027	0.03
BM 4	3	17.05	0.0010	460.4	<0.027	0.03
BM 5	4	3.5	0.0089	94.5	0.240	0.27
BM 6	5	12.28	0.0341	331.6	0.921	1.04
BM 7	6	2.92	0.0197	78.8	0.532	0.47
BM 9	7	2.52	0.0281	68.0	0.759	0.85
BM 12	8	0.66	0.0063	17.8	0.170	0.19
BM 11	9	1.93	0.0116	52.1	0.313	0.35
BM 8	10	5.58	0.0050	150.5	0.135	0.15
BM 13	11	3.62	0.0193	97.7	0.521	0.59
BM 10	12	2.39	0.0375	64.4	1.012	1.14
BM 15	13	0.50	0.0036	13.4	0.097	0.11
BM 16	14	1.19	0.0143	32.2	0.386	0.43
BM 14	15	2.01	0.0168	54.3	0.454	0.51
BM 2	16	6.02	0.0258	162.5	0.697	0.78

oz - ounce mg - milligram yd^3 - cubic yard < - less than

BIA report no.: BM 1 ENGINEERING REPORT

CLIENT: U. S. Bureau of Mines
PROJECT: Aggregate Testing

JOB NO.: RM-2750-84
DATE: 10/16/84

Sample No.: 1
Sample Description: Grayish brown, sandy GRAVEL with occasional cobbles

I. BRIEF PETROGRAPHIC DESCRIPTION

Rock Type	Amount	Physical Condition	Anticipated Chemical Stability
Basalt	73%	Fresh, dense to moderately weathered, subangular to subrounded.	Potentially Reactive
Quartzite	19%		
Granite	7%		
Sandstone	Trace		

II. DELETERIOUS MATERIALS

Material	Suggestions for Eliminating or Mitigating Problems Caused by the Materials
1. Quartzite.	1. Verify effect with additional tests (IV.)
2. Some calcium carbonate coating on approximately half of aggregate.	2. Select pit areas and depths without coating. Crushing will reduce extent of coating.
3. Excess portion passing #200 sieve for some fine aggregate portion (-3/8") applications.	3. Wash process fine aggregate.

III. MATERIAL SUITABILITY (ROAD CONSTRUCTION)

APPLICATION

a) PORTLAND CEMENT CONCRETE (ASTM C-33)
*May be suitable. Will require crushing, screening and fine aggregate washing.

b) SUB-BASE (WY Highway Dept. 703.06)
Suitable. May require scalping of cobbles and screening.

c) BASE (WY Highway Dept. 703.06)
Suitable. Will require crushing and screening.

d) ASPHALT CONCRETE (Surface Courses)(ASTM D1073, ASTM D692)
*Suitable. Will require crushing and screening.

*If verified by additional tests (IV)

IV. SUGGESTIONS FOR FURTHER TESTING

TEST APPLICATION	REASON
a) ASTM C227	Determine if alkali-silica reaction is likely to cause expansive reactions in Portland cement concrete. Consider cement with less than 0.6% (as sodium oxide) alkalie.
d) ASTM D1075	Determine effect of water on cohesion of compacted bituminous mixtures.
d) ASTM D1664	Test for coating and stripping of bituminous aggregate mixtures.

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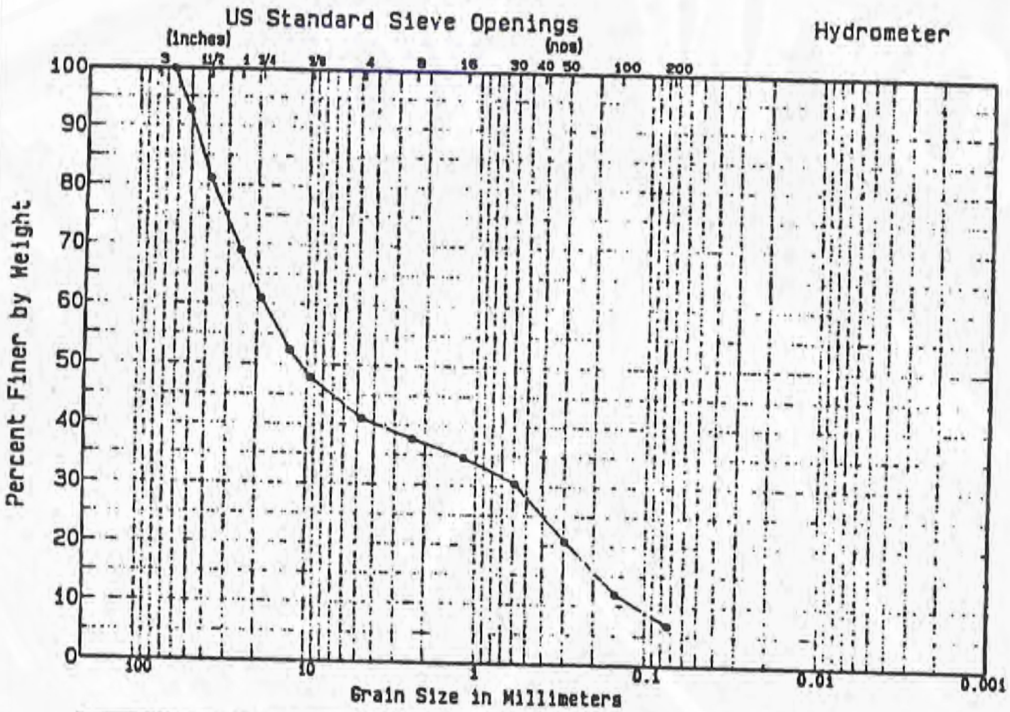
Reviewed by Jon C. Z[illegible] P.E.

BIA report no.: BM 1

PARTICLE SIZE ANALYSIS

Project: AGGREGATE TESTING
Job No.: RM-2750-84
Client: BUREAU OF MINES

Test Date: 8-10-84
Tested By: SLF



Cobbles	Coarse Gravel	Fine Gravel	Coarse Sand	Medium Sand	Fine Sand	Silt	Clay

Unified Soil Classification System (ASTM D2487)

Sample No.: 1
Sampled By: CLIENT
Source: WIND RIVER RES.

Soil Description: GR. BROWN SANDY GRAVEL W/OCC. COBBLES

Percent Gravel: 58
Percent Sand: 35
Percent Silt & Clay: 6

Reviewed By: RCM
Date: 10-16-84

INBERG - MILLER ENGINEERS

BIA report no.: BM 3 ENGINEERING REPORT

CLIENT: U. S. Bureau of Mines
PROJECT: Aggregate Testing

JOB NO.: RM-2750-84
DATE: 10/16/84

Sample No.: 2
Sample Description: Dark grayish brown, gravelly SAND with occasional cobbles

I. BRIEF PETROGRAPHIC DESCRIPTION

Rock Type	Amount	Physical Condition	Anticipated Chemical Stability
Limestone	51%	Fresh, dense to moderately weathered, trace highly weathered, subangular to subrounded.	Innocuous
Granite	28%		
Gabbro	14%		
Sandstone	3%		
Chert	3%		
Quartzite	Trace		

II. DELETERIOUS MATERIALS

Material	Suggestions for Eliminating or Mitigating Problems Caused by the Materials
1. Quartzite and chert.	Not recommended for use (see below).
2. Some calcium carbonate coating on approximately half of aggregate.	
3. Excess portion passing #200 sieve for some fine aggregate portion (-3/8") applications.	

III. MATERIAL SUITABILITY (ROAD CONSTRUCTION)

APPLICATION

a) PORTLAND CEMENT CONCRETE (ASTM C-33)
Not suitable; excessive ASTM C88 loss and high ASTM C131 and C535 loss.

b) SUB-BASE (WY Highway Dept. 703.06)
Not Suitable; excessive ASTM C88 loss.

c) BASE (WY Highway Dept. 703.06)
Not suitable; excessive ASTM C88 loss.

d) ASPHALT CONCRETE (Surface Courses)(ASTM D1073, ASTM D692)
Not suitable; excessive ASTM C88 loss and high ASTM C131 and C535 loss.

IV. SUGGESTIONS FOR FURTHER TESTING

TEST	REASON
- - -	- - -

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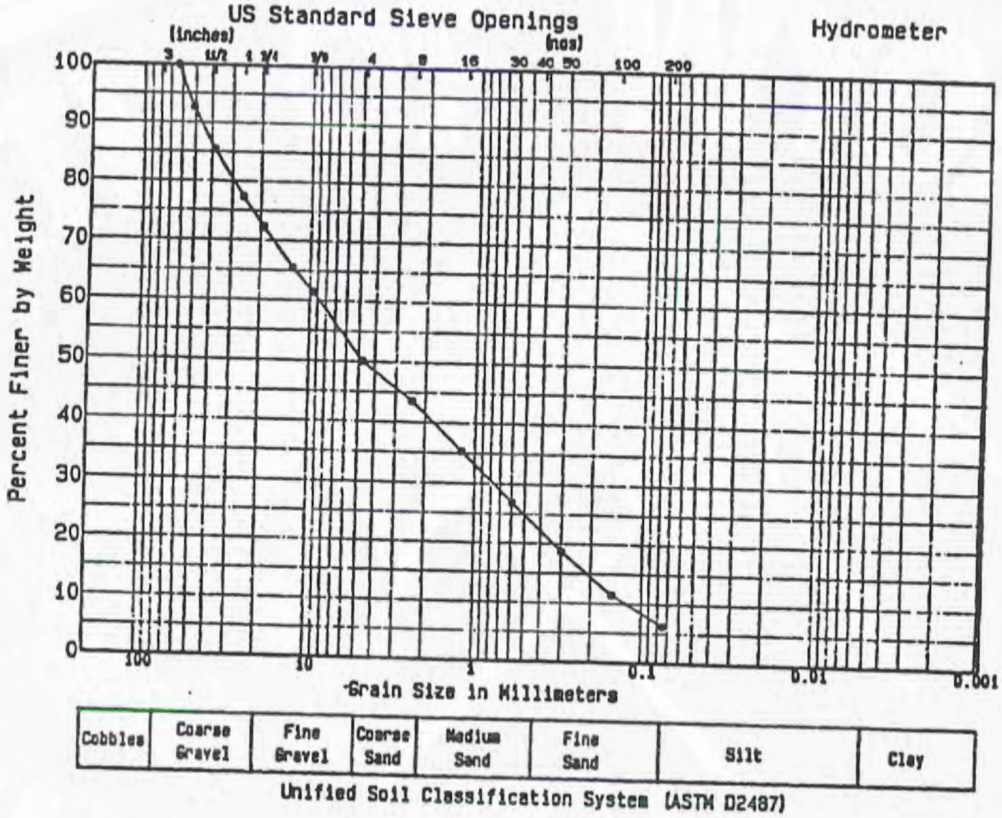
Reviewed by Jon C. Hamel P.E.

BIA report no.: BM 3

PARTICLE SIZE ANALYSIS

Project: AGGREGATE TESTING
Job No.: RM-2750-84
Client: U.S. BUREAU OF MINES

Test Date: 8-21-84
Tested By: CRL



Sample No.: 2
Sampled By: CLIENT
Source: WIND RIVER RES.

Soil Description: DK. GRAYISH BROWN GRAVELLY SAND W/ OCCAS. COBBLES

Percent Gravel: 49
Percent Sand: 44
Percent Silt & Clay: 6

Reviewed By: RCM
Date: 10-16-84

INBERG - MILLER ENGINEERS

RIVERTON, WYOMING

BIA report no.: BM 5

ENGINEERING REPORT

CLIENT: U. S. Bureau of Mines
PROJECT: Aggregate Testing

JOB NO.: RM-2750-84
DATE: 10/16/84

Sample No.: 4
Sample Description: Dark grayish brown, sandy GRAVEL with occasional cobbles

I. BRIEF PETROGRAPHIC DESCRIPTION

Rock Type	Amount	Physical Condition	Anticipated Chemical Stability
Granite	47%	Moderately weathered, subangular to subrounded	Potentially Reactive
Basalt	33%		
Quartzite	10%		
Quartz	5%		
Sandstone	4%		
Limestone	Trace		

II. DELETERIOUS MATERIALS

Material	Suggestions for Eliminating or Mitigating Problems Caused by the Materials
1. Quartzite and quartz.	1. Verify effect with additional tests (IV.)
2. Some calcium carbonate coating on approximately half of aggregate.	2. Select pit areas and depths without coating. Crushing will reduce extent of coating.

III. MATERIAL SUITABILITY (ROAD CONSTRUCTION)

APPLICATION

a) PORTLAND CEMENT CONCRETE (ASTM C-33)
*May be suitable. Will require crushing and screening.

b) SUB-BASE (WY Highway Dept. 703.06)
Suitable. May require scalping of cobbles.

c) BASE (WY Highway Dept. 703.06)
Suitable. Will require crushing.

d) ASPHALT CONCRETE (Surface Courses)(ASTM D1073, ASTM D692)
*Suitable. Will require crushing and screening.

*If verified by additional tests (IV)

IV. SUGGESTIONS FOR FURTHER TESTING

TEST APPLICATION	REASON
a) ASTM C227	Determine if alkali-silica reaction is likely to cause expansive reactions in Portland cement concrete. Consider cement with less than 0.6% (as sodium oxide) alkalie.
d) ASTM D1075	Determine effect of water on cohesion of compacted bituminous mixtures.
d) ASTM D1664	Test for coating and stripping of bituminous aggregate mixtures.

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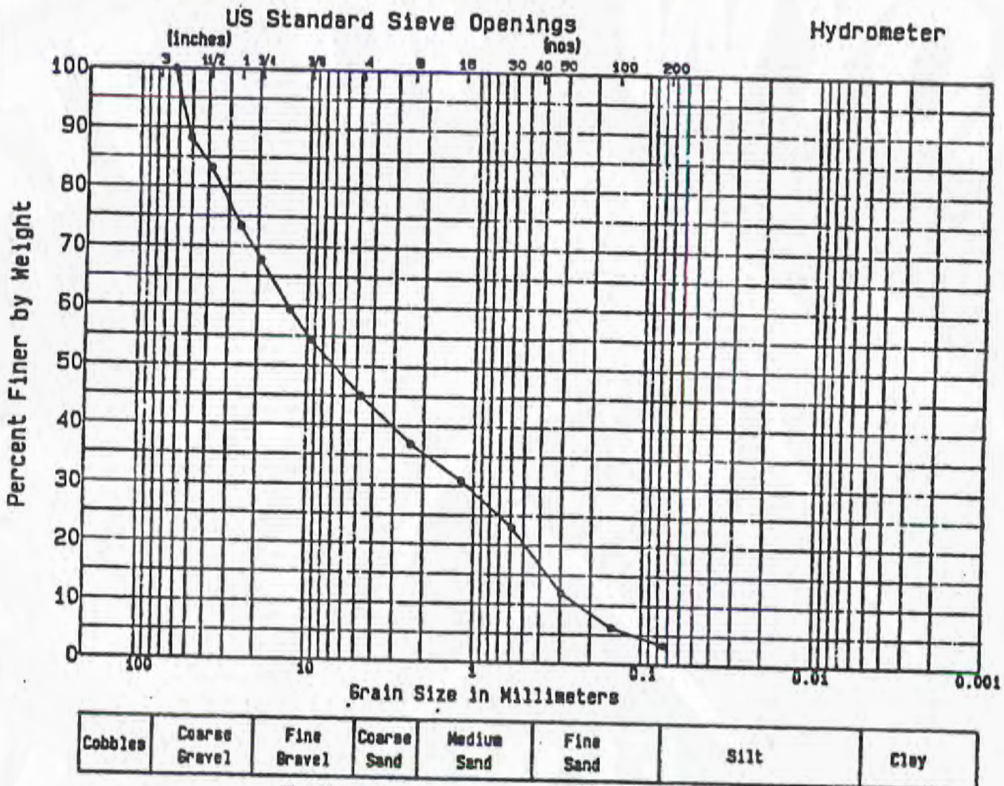
Reviewed by John C. Harrell P.E.

BIA report no.: BM 5

PARTICLE SIZE ANALYSIS

Project: AGGREGATE TESTING
Job No.: RM-2750-84
Client: U.S. BUREAU OF MINES

Test Date: 8-23-84
Tested By: CRL/SLF



Unified Soil Classification System (ASTM D2487)

Sample No.: 4
Sampled By: CLIENT
Source: WIND RIVER RES.

Soil Description: DK. GRAYISH BROWN GRAVELLY SAND W/OCCAS. COBBLES

Percent Gravel: 54
Percent Sand: 42
Percent Silt & Clay: 3

Reviewed By: RLM
Date: 10-16-84

INBERG - MILLER ENGINEERS

RIVERTON, WYOMING

ENGINEERING REPORT

CLIENT: U. S. Bureau of Mines
PROJECT: Aggregate Testing

JOB NO.: RM-2750-84
DATE: 10/16/84

Sample No.: 3
Sample Description: Dark grayish brown, gravelly SAND with occasional cobbles

I. BRIEF PETROGRAPHIC DESCRIPTION

Rock Type	Amount	Physical Condition	Anticipated Chemical Stability
Granite	89%	Generally moderately weathered, some aggregate highly weathered, subangular to subrounded.	Innocuous
Quartzite	5%		
Limestone	3%		
Basalt	2%		
Schist	Trace		

II. DELETERIOUS MATERIALS

Material	Suggestions for Eliminating or Mitigating Problems Caused by the Materials
1. Quartzite.	Not recommended for use (see below).
2. Some calcium carbonate coating on approximately half of aggregate.	

III. MATERIAL SUITABILITY (ROAD CONSTRUCTION)

APPLICATION

a) PORTLAND CEMENT CONCRETE (ASTM C-33)
Not suitable; excessive ASTM C88 loss, high ASTM C131 and C535 loss.

b) SUB-BASE (WY Highway Dept. 703.06)
Not Suitable; excessive ASTM C88 loss.

c) BASE (WY Highway Dept. 703.06)
Not Suitable; excessive ASTM C88 loss.

d) ASPHALT CONCRETE (Surface Courses)(ASTM D1073, ASTM D692)
Not suitable; excessive ASTM C88 loss, high ASTM C131 and C535 loss.

IV. SUGGESTIONS FOR FURTHER TESTING

TEST	REASON
- - -	- - -

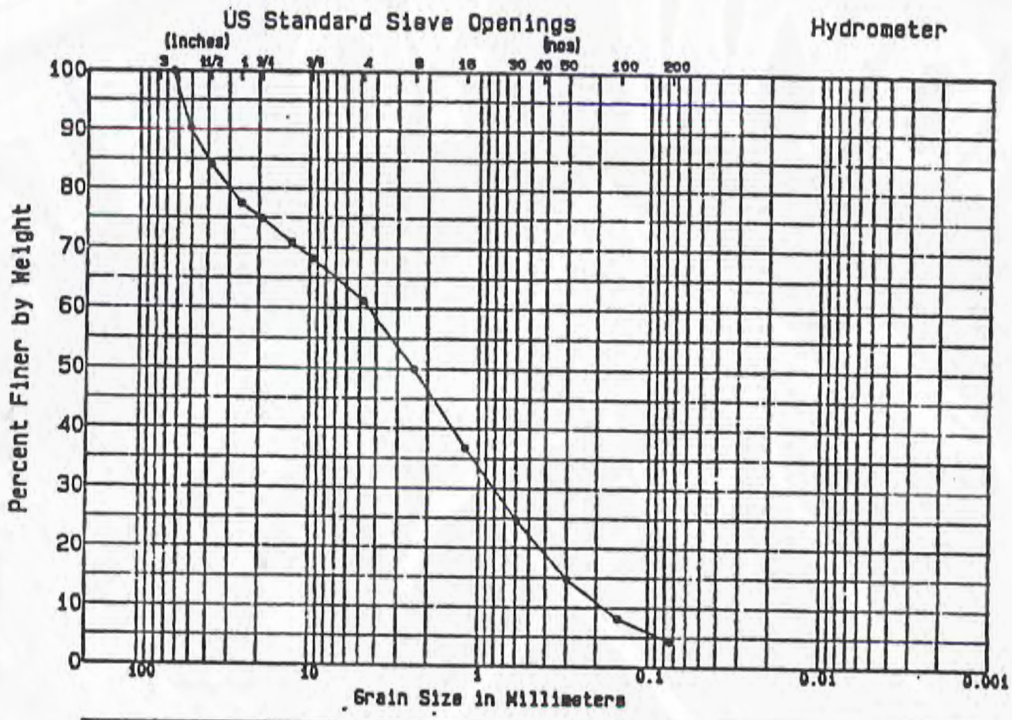
INBERG-MILLER ENGINEERS

Reviewed by Jon C. Hamel P.E.

PARTICLE SIZE ANALYSIS

Project: AGGREGATE TESTING
Job No.: RM-2750-84
Client: U.S. BUREAU OF MINES

Test Date: 8-23-84
Tested By: CRL



Cobbles	Coarse Gravel	Fine Gravel	Coarse Sand	Medium Sand	Fine Sand	Silt	Clay

Unified Soil Classification System (ASTM D2487)

Sample No.: 3
Sampled By: CLIENT
Source: WIND RIVER RES.

Soil Description: DK. GRAYISH BROWN GRAVELLY SAND W/OCCAS. COBBLES

Percent Gravel: 38
Percent Sand: 57
Percent Silt & Clay: 4

Reviewed By: RLM
Date: 10-16-84

INBERG - MILLER ENGINEERS
RIVERTON, WYOMING

BIA report no.: BM 6 ENGINEERING REPORT

CLIENT: U. S. Bureau of Mines
PROJECT: Aggregate Testing

JOB NO.: RM-2750-84
DATE: 10/16/84

Sample No.: 5
Sample Description: Dark grayish brown, sandy GRAVEL with occasional cobbles

I. BRIEF PETROGRAPHIC DESCRIPTION

Rock Type	Amount	Physical Condition	Anticipated Chemical Stability
Basalt	63%	Fresh, dense to moderately weathered, subangular to subrounded.	Potentially Reactive
Granite	27%		
Quartzite	7%		
Limestone	3%		

II. DELETERIOUS MATERIALS

Material	Suggestions for Eliminating or Mitigating Problems Caused by the Materials
1. Quartzite.	1. Verify effect with additional tests (IV.)
2. Some calcium carbonate coating on approximately one-fourth of aggregate.	2. Select pit areas and depths without coating. Crushing will reduce extent of coating.
3. Clay coating on some aggregate.	3. Wash process fine aggregate.

III. MATERIAL SUITABILITY (ROAD CONSTRUCTION)

APPLICATION

a) PORTLAND CEMENT CONCRETE (ASTM C-33)
*May be Suitable. Will require crushing, screening and may require washing.

b) SUB-BASE (WY Highway Dept. 703.06)
Suitable. May require scalping of cobbles.

c) BASE (WY Highway Dept. 703.06)
Suitable. Will require crushing.

d) ASPHALT CONCRETE (Surface Courses)(ASTM D1073, ASTM D692)
*Suitable. Will require crushing and screening.

*If verified by additional tests (IV)

IV. SUGGESTIONS FOR FURTHER TESTING

TEST APPLICATION	REASON
a) ASTM C227	Determine if alkali-silica reaction is likely to cause expansive reactions in Portland cement concrete. Consider cement with less than 0.6% (as sodium oxide) alkalie.
d) ASTM D1075	Determine effect of water on cohesion of compacted bituminous mixtures.
d) ASTM D1664	Test for coating and stripping of bituminous aggregate mixtures.

INBERG-MILLER ENGINEERS

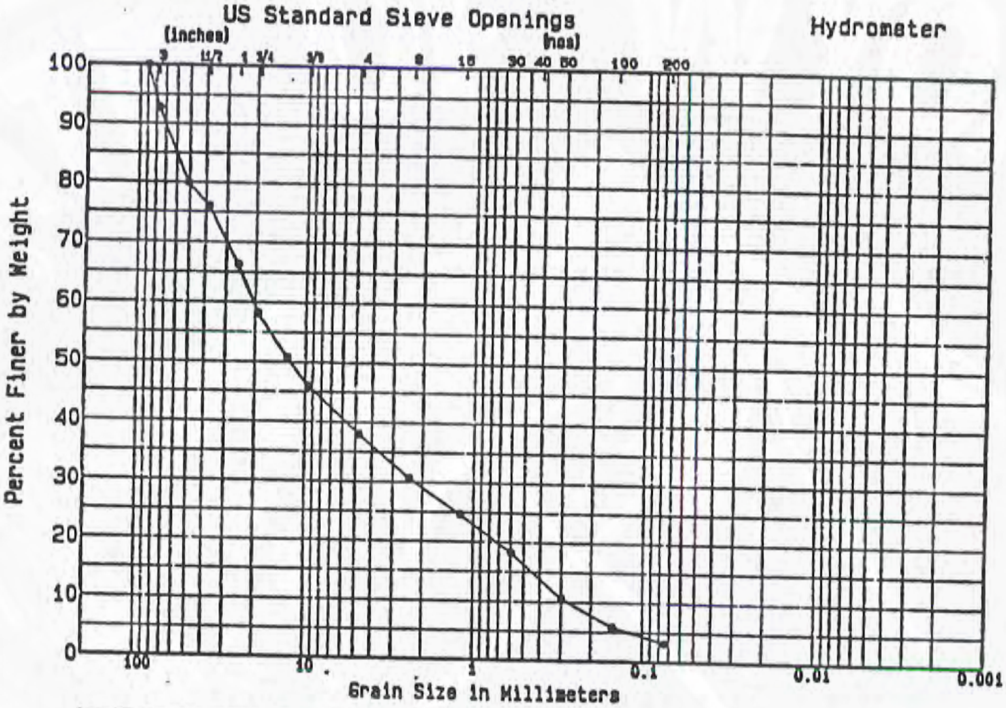
Reviewed by Jon C. [signature] P.E.

BIA report no.: BM 6

PARTICLE SIZE ANALYSIS

Project: AGGREGATE TESTING
Job No.: RM-2750-84
Client: U.S. BUREAU OF MINES

Test Date: 8-27-84
Tested By: DDH



Cobbles	Coarse Gravel	Fine Gravel	Coarse Sand	Medium Sand	Fine Sand	Silt	Clay

Unified Soil Classification System (ASTM D2487)

Sample No.: 5
Sampled By: CLIENT
Source: WIND RIVER RES.

Soil Description: DK. GRAYISH BROWN SANDY GRAVEL W/OCCAS. COBBLES

Percent Gravel: 62
Percent Sand: 35
Percent Silt & Clay: 3

Reviewed By: RLM
Date: 10-16-84

INBERG - MILLER ENGINEERS

RIVERTON, WYOMING

BIA report no.: BM 7 ENGINEERING REPORT

CLIENT: U. S. Bureau of Mines
PROJECT: Aggregate Testing

JOB NO.: RM-2750-84
DATE: 10/16/84

Sample No.: 6
Sample Description: Dark grayish brown, sandy GRAVEL with occasional cobbles

I. BRIEF PETROGRAPHIC DESCRIPTION

Rock Type	Amount	Physical Condition	Anticipated Chemical Stability
Granite	49%	Moderately weathered, subrounded.	Potentially Reactive
Quartzite	41%		
Basalt	9%		
Limestone	Trace		
Chert	Trace		
Quartz	Trace		

II. DELETERIOUS MATERIALS

Material	Suggestions for Eliminating or Mitigating Problems Caused by the Materials
1. Quartzite, quartz, chert.	1. Verify effect with additional tests (IV.)
2. Some calcium carbonate coating on approximately one third of aggregate.	2. Select pit areas and depths without coating. Crushing will reduce extent of coating.
3. Excess portion passing #200 sieve for some fine aggregate portion (-3/8") application.	3. Do not use for fine aggregate in Portland cement or asphalt concrete (see below).

III. MATERIAL SUITABILITY (ROAD CONSTRUCTION)

APPLICATION

a) PORTLAND CEMENT CONCRETE (ASTM C-33)
Fine aggregate not suitable. Excessive ASTM C88 loss. *Coarse aggregate may be suitable. Will require crushing and screening.

b) SUB-BASE (WY Highway Dept. 703.06)
Suitable. May require scalping of cobbles and screening.

c) BASE (WY Highway Dept. 703.06)
Suitable. Will require crushing and screening.

d) ASPHALT CONCRETE (Surface Courses)(ASTM D1073, ASTM D692)
Fine aggregate not suitable. Excessive ASTM C88 loss. *Coarse aggregate suitable. Will require crushing and screening.

*If verified by additional tests (IV)

IV. SUGGESTIONS FOR FURTHER TESTING

TEST APPLICATION	REASON
a) ASTM C227	Determine if alkali-silica reaction is likely to cause expansive reactions in Portland cement concrete. Consider cement with less than 0.6% (as sodium oxide) alkalie.
d) ASTM D1075	Determine effect of water on cohesion of compacted bituminous mixtures.
d) ASTM D1664	Test for coating and stripping of bituminous aggregate mixtures.

INBERG-MILLER ENGINEERS

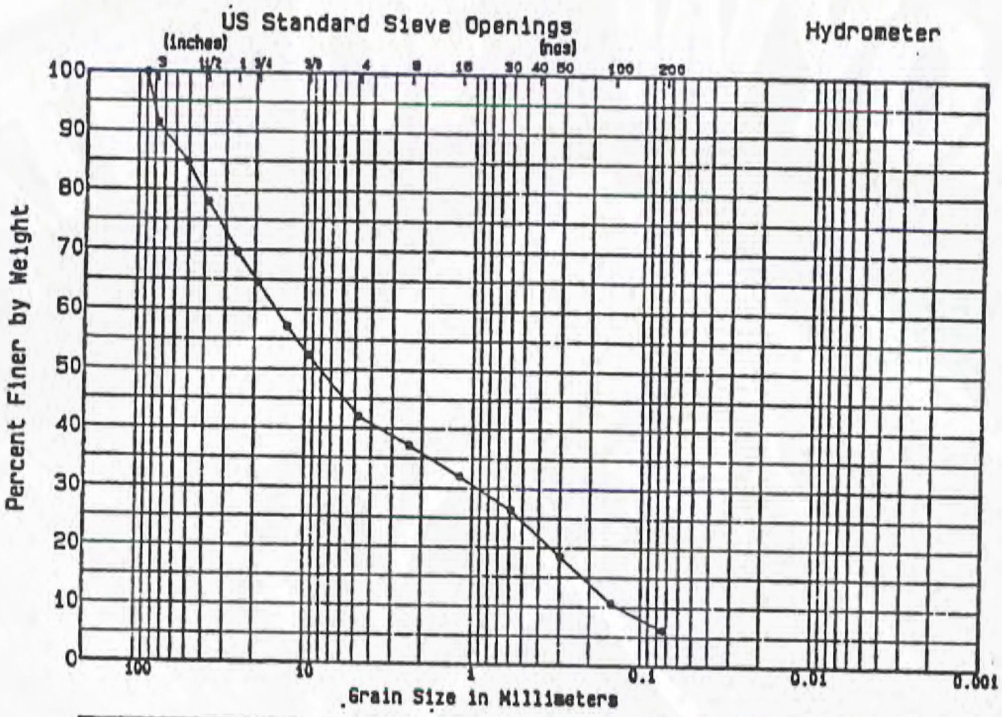
Reviewed by Jon C. [signature] P.E.

BIA report no.: BM 7

PARTICLE SIZE ANALYSIS

Project: AGGREGATE TESTING
Job No.: RM-2750-84
Client: U.S. BUREAU OF MINES

Test Date: 8-27-84
Tested By: DDH



Cobbles	Coarse Gravel	Fine Gravel	Coarse Sand	Medium Sand	Fine Sand	Silt	Clay

Unified Soil Classification System (ASTM D2487)

Sample No.: 6
Sampled By: CLIENT
Source: WIND RIVER RES.

Soil Description: DK. GRAYISH BROWN SANDY GRAVEL W/OCCAS. COBBLES

Percent Gravel: 57
Percent Sand: 36
Percent Silt & Clay: 6

Reviewed By: RLM
Date: 10-16-84

INBERG - MILLER ENGINEERS

RIVERTON, WYOMING

BIA report no.: BM 9 ENGINEERING REPORT

CLIENT: U. S. Bureau of Mines
PROJECT: Aggregate Testing

JOB NO.: RM-2750-84
DATE: 10/16/84

Sample No.: 7
Sample Description: Dark grayish brown, gravelly SAND with occasional cobbles

I. BRIEF PETROGRAPHIC DESCRIPTION

Type	Amount	Physical Condition	Anticipated Chemical Stability
Granite	35%	Fresh, dense to moderately weathered, subangular to subrounded.	Potentially Reactive
Rhyolite	20%		
Quartzite	20%		
Basalt	11%		
Limestone	9		
Sandstone	2		
Quartz	Trace		
Chert	Trace		

II. DELETERIOUS MATERIALS

Material	Suggestions for Eliminating or Mitigating Problems Caused by the Materials
1. Quartzite, quartz, rhyolite, chert.	1. Verify effect with additional tests (IV.)
2. Some calcium carbonate coating on approximately one third of aggregate.	2. Select pit areas and depths without coating.
3. Excess portion passing #200 sieve for some fine aggregate portion (-3/8") application.	3. Wash process fine aggregate.

III. MATERIAL SUITABILITY (ROAD CONSTRUCTION)
APPLICATION

a) PORTLAND CEMENT CONCRETE (ASTM C-33)
*May be suitable. Will require crushing, screening and fine aggregate washing.

b) SUB-BASE (WY Highway Dept. 703.06)
Suitable. May require scalping of cobbles.

c) BASE (WY Highway Dept. 703.06)
Suitable. Will require crushing.

d) ASPHALT CONCRETE (Surface Courses)(ASTM D1073, ASTM D692)
*Suitable. Will require crushing and screening.

*If verified by additional tests (IV)

IV. SUGGESTIONS FOR FURTHER TESTING

TEST APPLICATION	REASON
a) ASTM C227	Determine if alkali-silica reaction is likely to cause expansive reactions in Portland cement concrete. Consider cement with less than 0.6% (as sodium oxide) alkalie.
d) ASTM D1075	Determine effect of water on cohesion of compacted bituminous mixtures.
d) ASTM D1664	Test for coating and stripping of bituminous aggregate mixtures.

INBERG-MILLER ENGINEERS

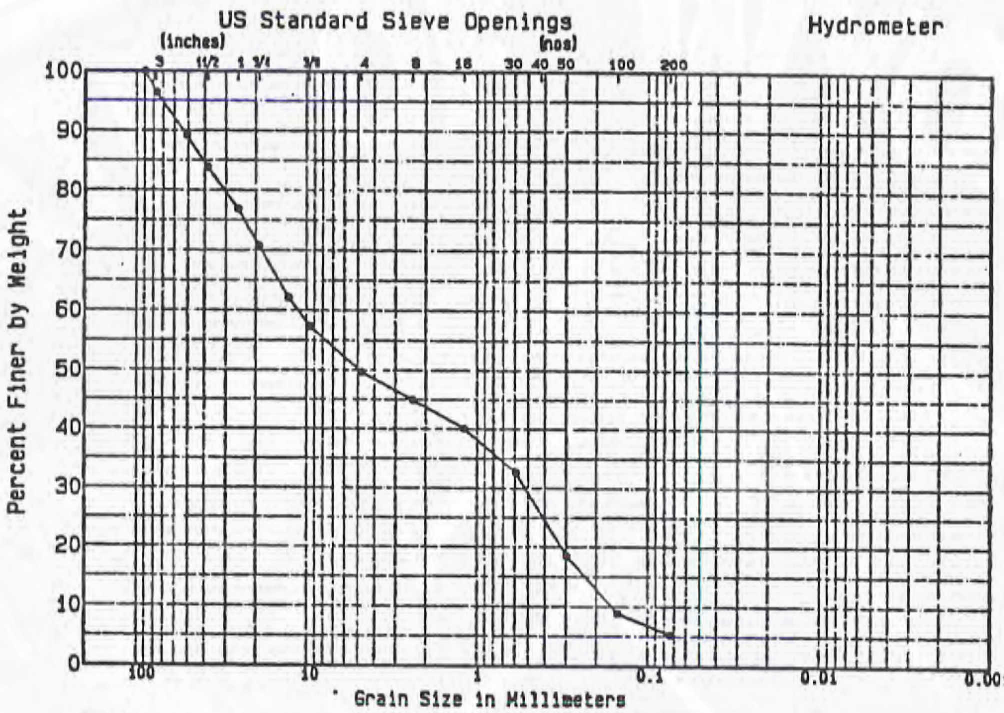
Reviewed by Jon C. Howell P.E.

BIA report no.: BM 9

PARTICLE SIZE ANALYSIS

Project: AGGREGATE TESTING
Job No.: RM-2750-84
Client: U.S. BUREAU OF MINES

Test Date: 8-28-84
Tested By: DDH



Cobbles	Coarse Gravel	Fine Gravel	Coarse Sand	Medium Sand	Fine Sand	Silt	Clay

Unified Soil Classification System (ASTM D2487)

Sample No.: 7
Sampled By: CLIENT
Source: WIND RIVER RES.

Soil Description: DK. GRAYISH BROWN GRAVELLY SAND W/OCCAS. COBBLES

Percent Gravel: 50
Percent Sand: 45
Percent Silt & Clay: 5

Reviewed By: RLM
Date: 10-16-84

INBERG - MILLER ENGINEERS

BIA report no.: BM 12 ENGINEERING REPORT

CLIENT: U. S. Bureau of Mines
PROJECT: Aggregate Testing

JOB NO.: RM-2750-84
DATE: 10/16/84

Sample No.: 8
Sample Description: Dark grayish brown, gravelly SAND with occasional cobbles

I. BRIEF PETROGRAPHIC DESCRIPTION

Type	Amount	Physical Condition	Anticipated Chemical Stability
Limestone	27%	Fresh, dense to moderately weathered, subangular to subrounded.	Innocuous
Quartzite	24%		
Sandstone	24%		
Shale	12%		
Granite	11%		
Schist	Trace		

II. DELETERIOUS MATERIALS

Material	Suggestions for Eliminating or Mitigating Problems Caused by the Materials
1. Quartzite.	Not recommended for use. (see below)
2. Some calcium carbonate coating on approximately one third of aggregate.	
3. Excess portion passing #200 sieve for some fine aggregate portion (-3/8") application.	

III. MATERIAL SUITABILITY (ROAD CONSTRUCTION)

APPLICATION

a) PORTLAND CEMENT CONCRETE (ASTM C-33)
Not suitable. Excessive ASTM C88 and ASTM C131 loss.

b) SUB-BASE (WY Highway Dept. 703.06)
Not Suitable. Excessive ASTM C131 loss.

c) BASE (WY Highway Dept. 703.06)
Not Suitable. Excessive ASTM C131 loss.

d) ASPHALT CONCRETE (Surface Courses)(ASTM D1073, ASTM D692)
Not suitable. Excessive ASTM C88 and ASTM C131 loss.

IV. SUGGESTIONS FOR FURTHER TESTING

TEST	REASON
- - -	- - -

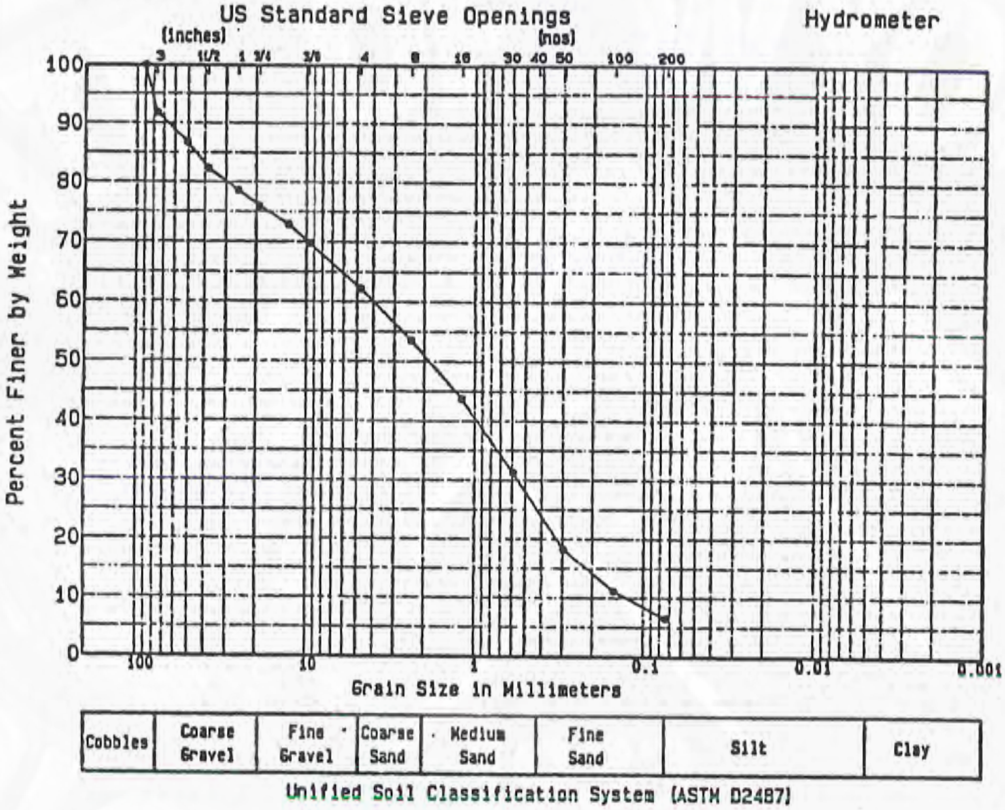
INBERG-MILLER ENGINEERS

Reviewed by Jon C. [illegible] P.E.

PARTICLE SIZE ANALYSIS

Project: AGGREGATE TESTING
Job No.: RM-2750-84
Client: U.S. BUREAU OF MINES

Test Date: 8-29-84
Tested By: DDH



Sample No.: 8
Sampled By: CLIENT
Source: WIND RIVER RES.

Soil Description: DK. GRAYISH BROWN GRAVELLY SAND W/OCCAS. COBBLES

Percent Gravel: 37
Percent Sand: 56
Percent Silt & Clay: 6

Reviewed By: RGM
Date: 10-16-84

INBERG - MILLER ENGINEERS

BIA report no.: BM 11 ENGINEERING REPORT

CLIENT: U. S. Bureau of Mines
PROJECT: Aggregate Testing

JOB NO.: RM-2750-84
DATE: 10/16/84

Sample No.: 9
Sample Description: Brown, gravelly SAND with occasional cobbles

I. BRIEF PETROGRAPHIC DESCRIPTION

Rock Type	Amount	Physical Condition	Anticipated Chemical Stability
Granite	77%	Fresh, dense to moderately weathered, subangular to subrounded.	Innocuous
Quartzite	17%		
Limestone	3%		
Basalt	2%		
Sandstone	Trace		
Chert	Trace		

II. DELETERIOUS MATERIALS

Material	Suggestions for Eliminating or Mitigating Problems Caused by the Materials
1. Quartzite, chert.	1. Not expected to be reactive but may be confirmed with additional tests (IV).
2. Some calcium carbonate coating on most of the aggregate.	2. Select pit areas and depths without coating. Crushing will reduce extent of coating.
3. Excess portion passing #200 sieve for some fine aggregate portion (-3/8") application.	3. Wash process fine aggregate.

III. MATERIAL SUITABILITY (ROAD CONSTRUCTION)

APPLICATION

a) PORTLAND CEMENT CONCRETE (ASTM C-33)
Suitable. Will require crushing, screening and fine aggregate washing.

b) SUB-BASE (WY Highway Dept. 703.06)
Suitable. May require scalping of cobbles and screening.

c) BASE (WY Highway Dept. 703.06)
Suitable. Will require crushing and screening.

d) ASPHALT CONCRETE (Surface Courses)(ASTM D1073, ASTM D692)
*Suitable. Will require crushing and screening.

*If verified by additional tests (IV)

IV. SUGGESTIONS FOR FURTHER TESTING

TEST APPLICATION	REASON
a) ASTM C227	Determine if alkali-silica reaction is likely to cause expansive reactions in Portland cement concrete.
d) ASTM D1075	Determine effect of water on cohesion of compacted bituminous mixtures.
d) ASTM D1664	Test for coating and stripping of bituminous aggregate mixtures.

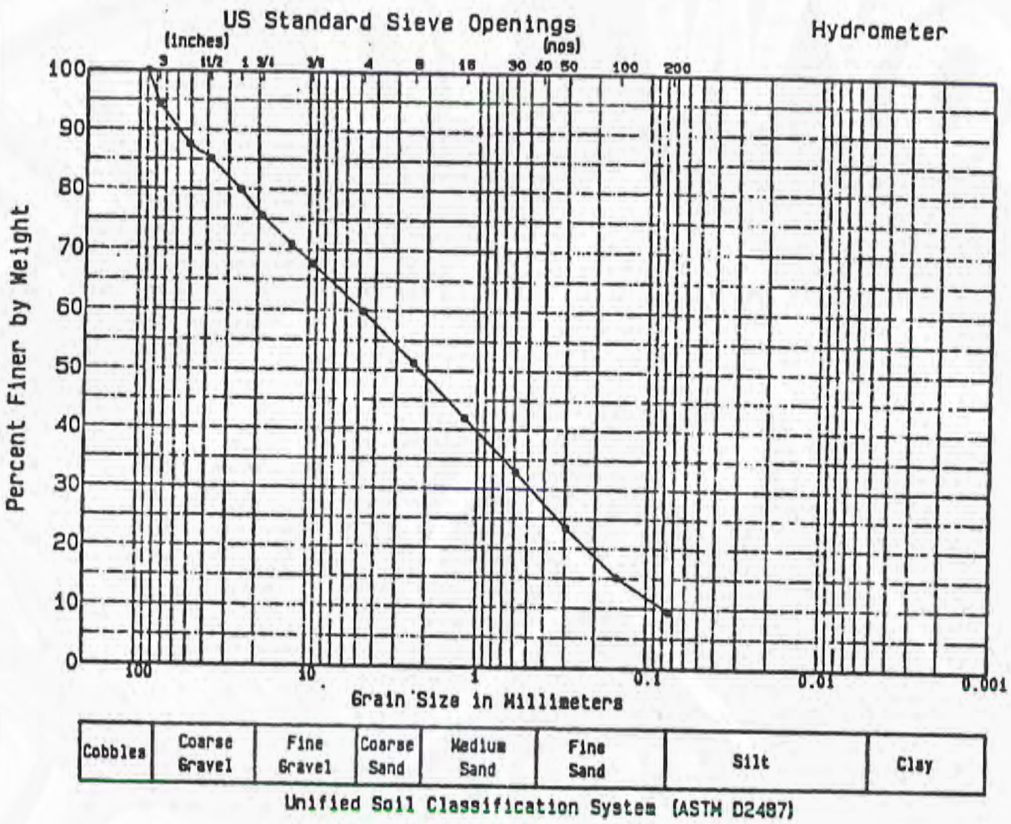
INBERG-MILLER ENGINEERS

Reviewed by Jon C. [signature] P.E.

PARTICLE SIZE ANALYSIS

Project: AGGREGATE TESTING
Job No.: RM-2750-84
Client: U.S. BUREAU OF MINES

Test Date: 8-30-84
Tested By: DDH



Sample No.: 9
Sampled By: CLIENT
Source: WIND RIVER RES.

Soil Description: BROWN GRAVELLY SAND W/OCCAS. COBBLES

Percent Gravel: 40
Percent Sand: 51
Percent Silt & Clay: 9

Reviewed By: RLM
Date: 10-16-84

INBERG - MILLER ENGINEERS

BIA report no.: BM 8 ENGINEERING REPORT

CLIENT: U. S. Bureau of Mines
PROJECT: Aggregate Testing

JOB NO.: RM-2750-84
DATE: 10/16/84

Sample No.: 10
Sample Description: Dark grayish brown, sandy GRAVEL with occasional cobbles

I. BRIEF PETROGRAPHIC DESCRIPTION

Rock Type	Amount	Physical Condition	Anticipated Chemical Stability
Granite	64%	Fresh, dense to moderately weathered, subangular to subrounded.	Potentially Reactive
Hornblende	11%		
Basalt	10%		
Quartzite	8%		
Limestone	4%		
Rhyolite	2%		
Chert	Trace		

II. DELETERIOUS MATERIALS

Material	Suggestions for Eliminating or Mitigating Problems Caused by the Materials
1. Quartzite, chert, rhyolite.	1. Verify effect with additional tests (IV.)
2. Some calcium carbonate coating on approximately one third of aggregate.	2. Select pit areas and depths without coating. Crushing will reduce extent of coating.
3. Excess portion passing #200 sieve for some fine aggregate portion (-3/8") application.	3. Screen fine aggregate for use in asphalt concrete.

III. MATERIAL SUITABILITY (ROAD CONSTRUCTION)

APPLICATION

a) PORTLAND CEMENT CONCRETE (ASTM C-33)
Fine aggregate not suitable. Excessive ASTM C-88 loss. *Coarse aggregate may be suitable. Will require crushing and screening.

b) SUB-BASE (WY Highway Dept. 703.06)
Suitable. May require scalping of cobbles and screening.

c) BASE (WY Highway Dept. 703.06)
Suitable. Will require crushing and screening.

d) ASPHALT CONCRETE (Surface Courses)(ASTM D1073, ASTM D692)
*Suitable. Will require crushing and screening.

*If verified by additional tests (IV)

IV. SUGGESTIONS FOR FURTHER TESTING

TEST APPLICATION	REASON
a) ASTM C227	Determine if alkali-silica reaction is likely to cause expansive reactions in Portland cement concrete. Consider cement with less than 0.6% (as sodium oxide) alkalie.
d) ASTM D1075	Determine effect of water on cohesion of compacted bituminous mixtures.
d) ASTM D1664	Test for coating and stripping of bituminous aggregate mixtures.

INBERG-MILLER ENGINEERS

Reviewed by Jon C. Howell P.E.

PARTICLE SIZE ANALYSIS

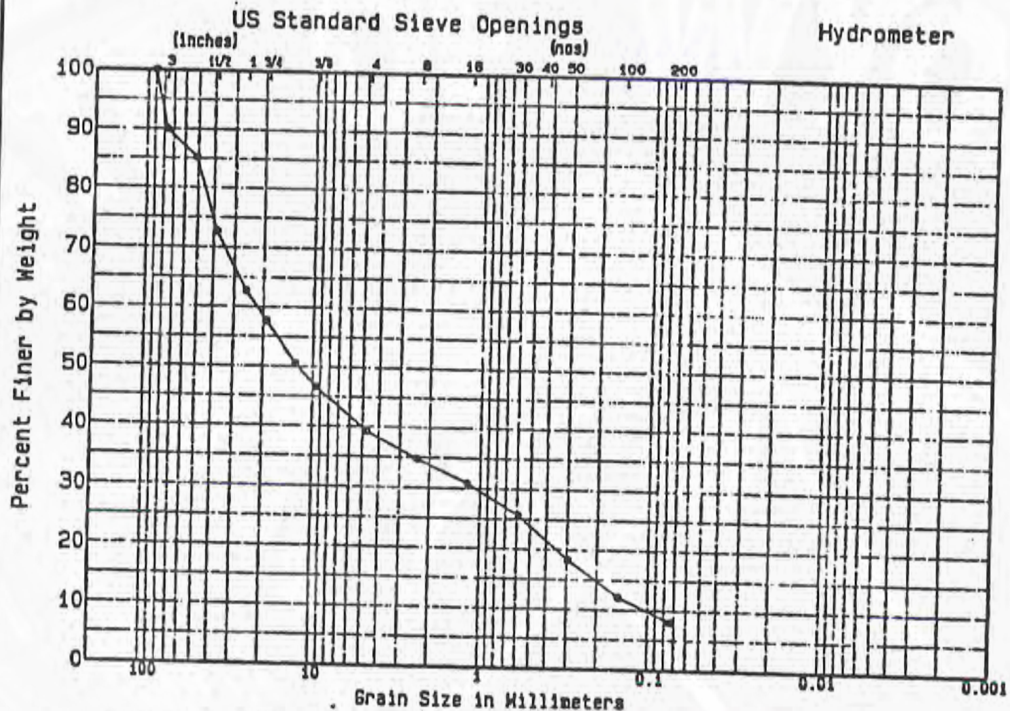
Project: AGGREGATE TESTING

Job No.: RM-2750-84

Client: U.S. BUREAU OF MINES

Test Date: 8-30-84

Tested By: CRL/DDH



Cobbles	Coarse Gravel	Fine Gravel	Coarse Sand	Medium Sand	Fine Sand	Silt	Clay

Unified Soil Classification System (ASTM D2487)

Sample No.: 10

Sampled By: CLIENT

Source: WIND RIVER RES.

Soil Description: DK. GRAYISH BROWN SANDY GRAVEL W/OCCAS. COBBLES

Percent Gravel: 60

Percent Sand: 32

Percent Silt & Clay: 8

Reviewed By: RLM

Date: 10-16-84

INBERG - MILLER ENGINEERS

BIA report no.: BM 13 ENGINEERING REPORT

CLIENT: U. S. Bureau of Mines
PROJECT: Aggregate Testing

JOB NO.: RM-2750-84
DATE: 10/16/84

Sample No.: 11
Sample Description: Dark brown, sandy GRAVEL with occasional cobbles

I. BRIEF PETROGRAPHIC DESCRIPTION

Rock Type	Amount	Physical Condition	Anticipated Chemical Stability
Granite	66%	Fresh, dense to moderately weathered, subangular to subrounded.	Potentially Reactive
Limestone	12%		
Sandstone	9%		
Basalt	8%		
Quartzite	5%		

II. DELETERIOUS MATERIALS

Material	Suggestions for Eliminating or Mitigating Problems Caused by the Materials
1. Quartzite. 2. Some calcium carbonate coating on approximately one third of aggregate. 3. Excess portion passing #200 sieve for some fine aggregate portion (-3/8") application.	Not recommended for use (see below).

III. MATERIAL SUITABILITY (ROAD CONSTRUCTION)

APPLICATION

a) PORTLAND CEMENT CONCRETE (ASTM C-33)
Not suitable. Excessive ASTM C-88 loss.

b) SUB-BASE (WY Highway Dept. 703.06)
Not Suitable. Excessive ASTM C-88 loss.

c) BASE (WY Highway Dept. 703.06)
Not Suitable. Excessive ASTM C-88 loss.

d) ASPHALT CONCRETE (Surface Courses)(ASTM D1073, ASTM D692)
Not Suitable. Excessive ASTM C-88 loss.

IV. SUGGESTIONS FOR FURTHER TESTING

TEST	REASON
- - -	- - -

INBERG-MILLER ENGINEERS

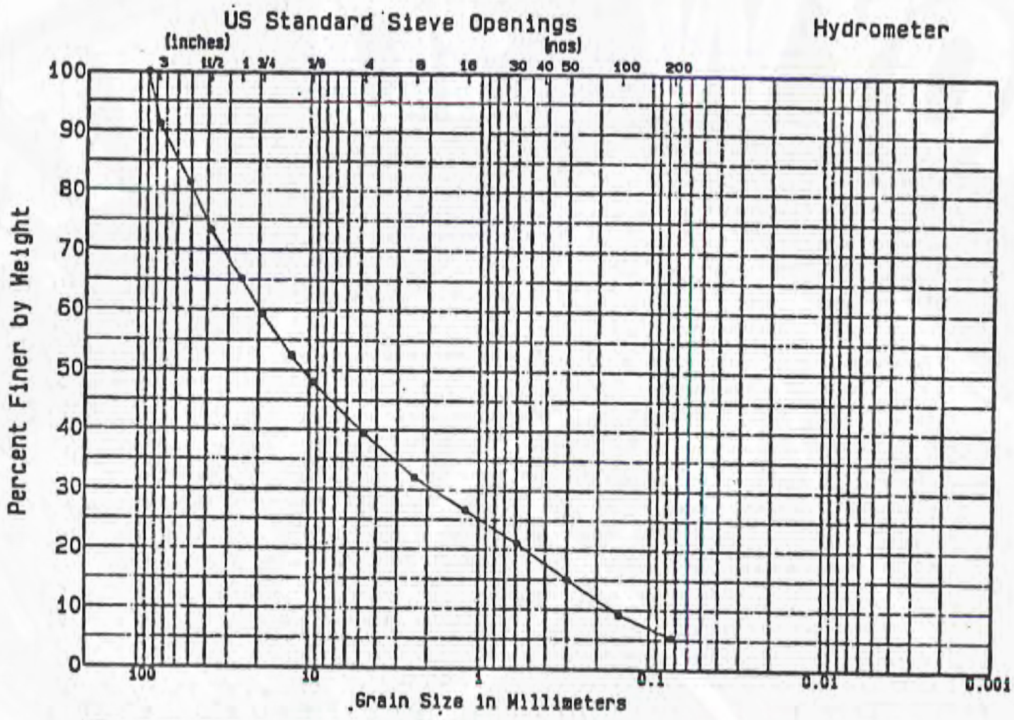
Reviewed by Jon C. Howell P.E.

BIA report no.: BM 13

PARTICLE SIZE ANALYSIS

Project: AGGREGATE TESTING
Job No.: RM-2750-84
Client: U.S. BUREAU OF MINES

Test Date: 8-29-84
Tested By: DDH



Cobbles	Coarse Gravel	Fine Gravel	Coarse Sand	Medium Sand	Fine Sand	Silt	Clay

Unified Soil Classification System (ASTM D2487)

Sample No.: 11
Sampled By: CLIENT
Source: WIND RIVER RES

Soil Description: DK. BROWN SANDY GRAVEL W/OCCAS. COBBLES

Percent Gravel: 60
Percent Sand: 35
Percent Silt & Clay: 5

Reviewed By: Rhm
Date: 10-16-84

INBERG - MILLER ENGINEERS

BIA report no.: BM 10 ENGINEERING REPORT

CLIENT: U. S. Bureau of Mines
PROJECT: Aggregate Testing

JOB NO.: RM-2750-84
DATE: 10/16/84

Sample No.: 12
Sample Description: Light olive brown, gravelly SAND with occasional cobbles

I. BRIEF PETROGRAPHIC DESCRIPTION

Rock Type	Amount	Physical Condition	Anticipated Chemical Stability
Basalt	12%	Fresh, dense to moderately weathered, subangular to subrounded.	Innocuous
Sandstone	4%		
Granite	4%		
Limestone	Trace		

II. DELETERIOUS MATERIALS

Material	Suggestions for Eliminating or Mitigating Problems Caused by the Materials
1. Quartzite.	1. Not expected to be reactive but may be confirmed by additional testing (IV).
2. Some calcium carbonate coating on approximately half of aggregate.	2. Select pit areas and depths without coating. Crushing will reduce extent of coating.

III. MATERIAL SUITABILITY (ROAD CONSTRUCTION)

APPLICATION

a) PORTLAND CEMENT CONCRETE (ASTM C-33)
Fine aggregate not suitable. Excessive ASTM C-88 loss. Coarse aggregate suitable. Will require crushing and screening.

b) SUB-BASE (WY Highway Dept. 703.06)
Suitable. May require scalping of cobbles.

c) BASE (WY Highway Dept. 703.06)
Suitable. Will require crushing.

d) ASPHALT CONCRETE (Surface Courses)(ASTM D1073, ASTM D692)
*Fine aggregate marginally suitable. *Coarse aggregate suitable. Will require crushing and screening.

*If verified by additional tests (IV)

IV. SUGGESTIONS FOR FURTHER TESTING

TEST APPLICATION	REASON
a) ASTM C227	Determine if alkali-silica reaction is likely to cause expansive reactions in Portland cement concrete. Consider cement with less than 0.6% (as sodium oxide) alkalie.
d) ASTM D1075	Determine effect of water on cohesion of compacted bituminous mixtures.
d) ASTM D1664	Test for coating and stripping of bituminous aggregate mixtures.

INBERG-MILLER ENGINEERS

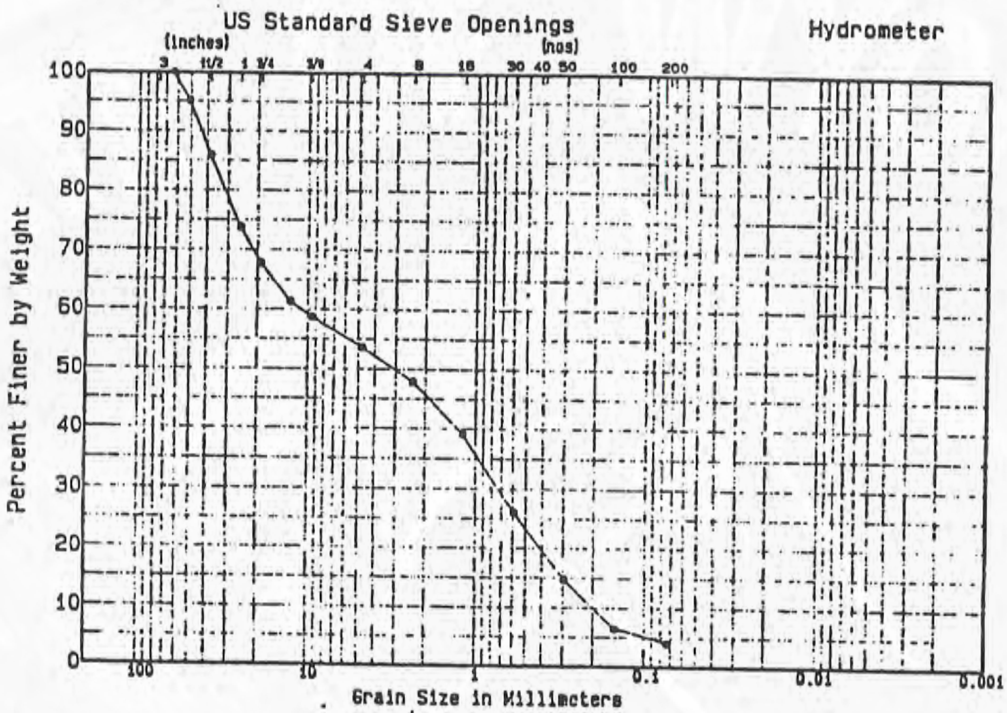
Reviewed by Jon C. Fowell P.E.

BIA report no.: BM 10

PARTICLE SIZE ANALYSIS

Project: AGGREGATE TESTING
Job No.: RM-2750-84
Client: U.S. BUREAU OF MINES

Test Date: 9-6-84
Tested By: CRL/SLF



Cobbles	Coarse Gravel	Fine Gravel	Coarse Sand	Medium Sand	Fine Sand	Silt	Clay

Unified Soil Classification System (ASTM D2487)

Sample No.: 12
Sampled By: CLIENT
Source: WIND RIVER RES.

Soil Description: LIGHT OLIVE BROWN GRAVELLY SAND

Percent Gravel: 46
Percent Sand: 50
Percent Silt & Clay: 4

Reviewed By: RLM
Date: 10-16-84

INBERG - MILLER ENGINEERS
RIVERTON, WYOMING

PARTICLE SIZE ANALYSIS

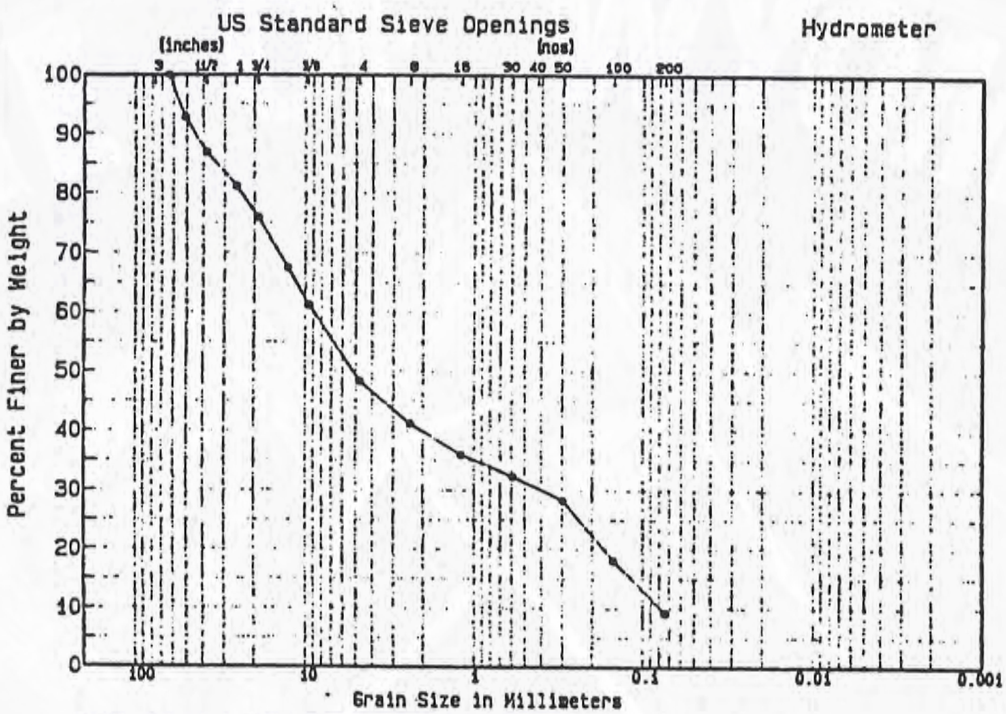
Project: AGGREGATE TESTING

Job No.: RM-2750-84

Client: BUREAU OF MINES

Test Date: 9-7-84

Tested By: WAU/SLF



Cobbles	Coarse Gravel	Fine Gravel	Coarse Sand	Medium Sand	Fine Sand	Silt	Clay

Unified Soil Classification System (ASTM D2487)

Sample No.: 13

Sampled By: CLIENT

Source: WIND RIVER RES.

Soil Description: GR. BROWN SANDY GRAVEL W/OCC. COBBLES

Percent Gravel: 51

Percent Sand: 40

Percent Silt & Clay: 9

Reviewed By: RLM

Date: 10-16-84

INBERG - MILLER ENGINEERS

BIA report no.: BM 15 ENGINEERING REPORT

CLIENT: U. S. Bureau of Mines
PROJECT: Aggregate Testing

JOB NO.: RM-2750-84
DATE: 10/16/84

Sample No.: 13
Sample Description: Grayish brown, sandy GRAVEL with occasional cobbles

I. BRIEF PETROGRAPHIC DESCRIPTION

Rock Type	Amount	Physical Condition	Anticipated Chemical Stability
Limestone	29%	Fresh, dense to moderately weathered, subangular to subrounded.	Innocuous
Chert	27%		
Quartzite	14%		
Granite	9%		
Sandstone	8%		
Basalt	7%		
Rhyolite	6%		

II. DELETERIOUS MATERIALS

Material	Suggestions for Eliminating or Mitigating Problems Caused by the Materials
1. Rhyolite, chert, quartzite.	1. Not expected to be reactive but may be confirmed by additional tests (IV).
2. Some calcium carbonate coating on approximately three-fourths of aggregate.	2. Select pit areas and depths without coating. Crushing will reduce extent of coating.
3. Excess portion passing #200 sieve for some fine aggregate portion (-3/8") application.	3. Wash process fine aggregate.

III. MATERIAL SUITABILITY (ROAD CONSTRUCTION)

APPLICATION

a) PORTLAND CEMENT CONCRETE (ASTM C-33)
Suitable. Will require crushing, screening and washing.

b) SUB-BASE (WY Highway Dept. 703.06)
Suitable. May require scalping of cobbles and screening.

c) BASE (WY Highway Dept. 703.06)
Suitable. Will require crushing and screening.

d) ASPHALT CONCRETE (Surface Courses)(ASTM D1073, ASTM D692)
*Suitable. Will require crushing and screening.

*If verified by additional tests (IV)

IV. SUGGESTIONS FOR FURTHER TESTING

TEST APPLICATION	REASON
a) ASTM C227	Determine if alkali-silica reaction is likely to cause expansive reactions in Portland cement concrete.
d) ASTM D1075	Determine effect of water on cohesion of compacted bituminous mixtures.
d) ASTM D1664	Test for coating and stripping of bituminous aggregate mixtures.

INBERG-MILLER ENGINEERS

Reviewed by Jon C. Howell P.E.

BIA report no.: BM 16 ENGINEERING REPORT

CLIENT: U. S. Bureau of Mines
PROJECT: Aggregate Testing

JOB NO.: RM-2750-84
DATE: 10/16/84

Sample No.: 14
Sample Description: Brown SAND with gravel and trace of silt

I. BRIEF PETROGRAPHIC DESCRIPTION

Rock Type	Amount	Physical Condition	Anticipated Chemical Stability
Basalt	42%	Fresh, dense to moderately weathered, subangular to subrounded.	Innocuous
Quartzite	26%		
Granite	12%		
Chert	9%		
Limestone	8%		
Sandstone	Trace		
Shale	Trace		

II. DELETERIOUS MATERIALS

Material	Suggestions for Eliminating or Mitigating Problems Caused by the Materials
1. Quartzite, chert.	1. Not expected to react but may be confirmed by additional testing (IV).
2. Some calcium carbonate coating on approximately one fourth of aggregate.	2. Select pit areas and depths without coating. Crushing will reduce extent of coating.
3. Excess portion passing #200 sieve for some fine aggregate portion (-3/8") application.	3. Wash process fine aggregate.

III. MATERIAL SUITABILITY (ROAD CONSTRUCTION)

APPLICATION

a) PORTLAND CEMENT CONCRETE (ASTM C-33)
Suitable. Will require crushing, screening and fine aggregate washing.

b) SUB-BASE (WY Highway Dept. 703.06)
Suitable. May require scalping of cobbles.

c) BASE (WY Highway Dept. 703.06)
Suitable. Will require crushing.

d) ASPHALT CONCRETE (Surface Courses) (ASTM D1073, ASTM D692)
*Suitable. Will require crushing and screening.

*If verified by additional tests (IV)

IV. SUGGESTIONS FOR FURTHER TESTING

TEST APPLICATION	REASON
a) ASTM C227	Determine if alkali-silica reaction is likely to cause expansive reactions in Portland cement concrete.
d) ASTM D1075	Determine effect of water on cohesion of compacted bituminous mixtures.
d) ASTM D1664	Test for coating and stripping of bituminous aggregate mixtures.

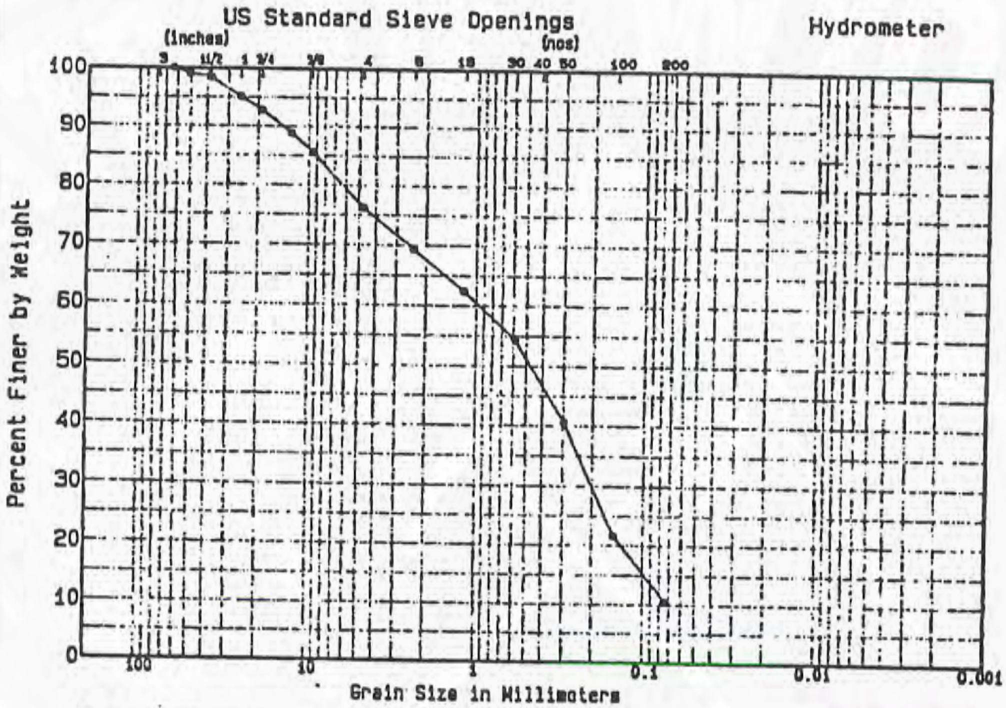
INBERG-MILLER ENGINEERS

Reviewed by Jon C. Hornell P.E.

PARTICLE SIZE ANALYSIS

Project: AGGREGATE TESTING
Job No.: RM-2750-84
Client: BUREAU OF MINES

Test Date: 9-10-84
Tested By: SLF



Cobbles	Coarse Gravel	Fine Gravel	Coarse Sand	Medium Sand	Fine Sand	Silt	Clay

Unified Soil Classification System (ASTM D2487)

Sample No.: 14
Sampled By: CLIENT
Source: WIND RIVER RES.

Soil Description: BROWN SAND W/GRAVEL AND TRACE OF SILT

Percent Gravel: 23
Percent Sand: 66
Percent Silt & Clay: 10

Reviewed By: RL [signature]
Date: 10-16-84

INBERG - MILLER ENGINEERS

BIA report no.: BM 14 ENGINEERING REPORT

CLIENT: U. S. Bureau of Mines
PROJECT: Aggregate Testing

JOB NO.: RM-2750-84
DATE: 10/16/84

Sample No.: 15
Sample Description: Brown, sandy GRAVEL with occasional cobbles

I. BRIEF PETROGRAPHIC DESCRIPTION

Rock Type	Amount	Physical Condition	Anticipated Chemical Stability
Granite	41%	Fresh, dense to moderately weathered, subangular to subrounded.	Potentially Reactive
Quartzite	31%		
Limestone	17%		
Sandstone	4%		
Gabbro	4%		
Basalt	Trace		
Chert	Trace		

II. DELETERIOUS MATERIALS

Material	Suggestions for Eliminating or Mitigating Problems Caused by the Materials
1. Chert, quartzite.	1. Verify effect with additional testing (IV).
2. Some calcium carbonate coating on approximately half of aggregate.	2. Select pit areas and depths without coating. Crushing will reduce extent of coating.
3. Excess portion passing #200 sieve for some fine aggregate portion (-3/8") applications.	3. Wash process fine aggregate.

III. MATERIAL SUITABILITY (ROAD CONSTRUCTION)
APPLICATION

a) PORTLAND CEMENT CONCRETE (ASTM C-33)
*May be suitable. Will require crushing, screening and fine aggregate washing.

b) SUB-BASE (WY Highway Dept. 703.06)
Suitable. May require scalping of cobbles.

c) BASE (WY Highway Dept. 703.06)
Suitable. Will require crushing. May require screening.

d) ASPHALT CONCRETE (Surface Courses)(ASTM D1073, ASTM D692)
*Suitable. Will require crushing and screening.

*If verified by additional tests (IV)

IV. SUGGESTIONS FOR FURTHER TESTING

TEST APPLICATION	REASON
a) ASTM C227	Determine if alkali-silica reaction is likely to cause expansive reactions in Portland cement concrete. Consider cement with less than 0.6% (as sodium oxide) alkalie.
d) ASTM D1075	Determine effect of water on cohesion of compacted bituminous mixtures.
d) ASTM D1664	Test for coating and stripping of bituminous aggregate mixtures.

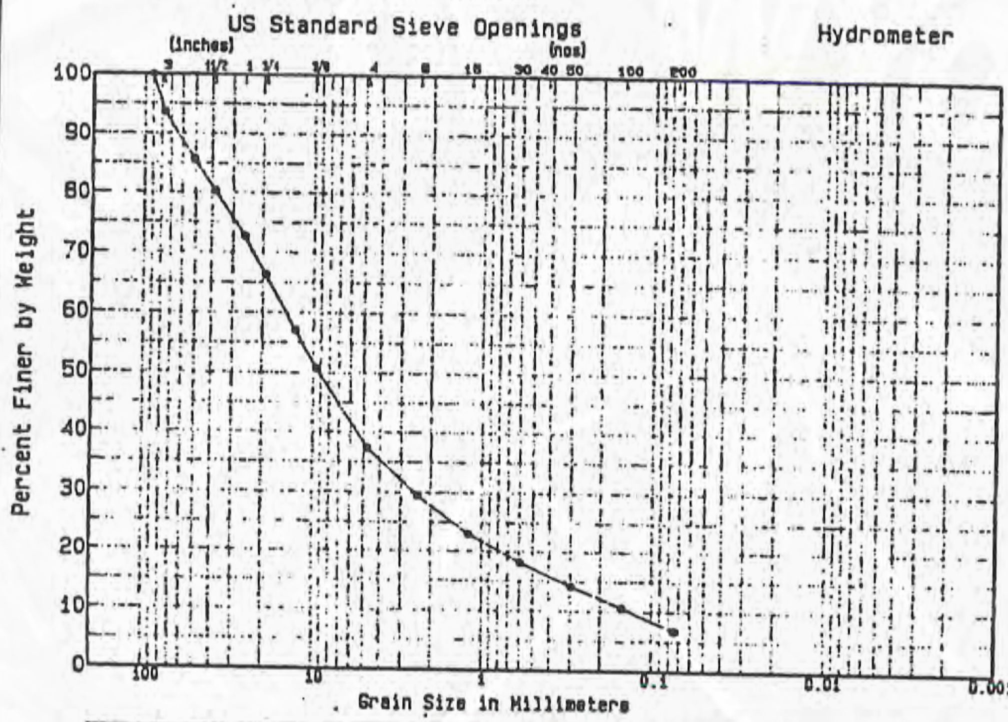
INBERG-MILLER ENGINEERS

Reviewed by Jon C. Howell P.E.

PARTICLE SIZE ANALYSIS

Project: AGGREGATE TESTING
Job No.: RM-2750-84
Client: BUREAU OF MINES

Test Date: 9-10-84
Tested By: SLF/CRL



Cobbles	Coarse Gravel	Fine Gravel	Coarse Sand	Medium Sand	Fine Sand	Silt	Clay

Unified Soil Classification System (ASTM D2487)

Sample No.: 15
Sampled By: CLIENT
Source: WIND RIVER RES.

Soil Description: BROWN SANDY GRAVEL

Percent Gravel: 62
Percent Sand: 31
Percent Silt & Clay: 6

Reviewed By: RLM
Date: 10-16-84

INBERG - MILLER ENGINEERS

BIA report no.: BM 2

ENGINEERING REPORT

CLIENT: U. S. Bureau of Mines
PROJECT: Aggregate Testing

JOB NO.: RM-2750-84
DATE: 10/16/84

Sample No.: 16
Sample Description: Dark grayish brown, sandy GRAVEL with occasional cobbles

I. BRIEF PETROGRAPHIC DESCRIPTION

Rock Type	Amount	Physical Condition	Anticipated Chemical Stability
Granite	45%	Fresh, dense to moderately weathered, subangular to subrounded.	Potentially Reactive
Basalt	33%		
Quartzite	16%		
Sandstone	4%		
Quartz	2%		

II. DELETERIOUS MATERIALS

Material	Suggestions for Eliminating or Mitigating Problems Caused by the Materials
1. Quartz, quartzite.	1. Verify effect with additional testing (IV).
2. Some calcium carbonate coating on approximately one-tenth of aggregate.	2. Select pit areas and depths without coating. Crushing will reduce extent of coating.

III. MATERIAL SUITABILITY (ROAD CONSTRUCTION)

APPLICATION

a) PORTLAND CEMENT CONCRETE (ASTM C-33)
*May be suitable. Will require crushing and screening.

b) SUB-BASE (WY Highway Dept. 703.06)
Suitable. May require scalping of cobbles.

c) BASE (WY Highway Dept. 703.06)
Suitable. Will require crushing.

d) ASPHALT CONCRETE (Surface Courses)(ASTM D1073, ASTM D692)
*Suitable. Will require crushing and screening.

*If verified by additional tests (IV)

IV. SUGGESTIONS FOR FURTHER TESTING

TEST APPLICATION	REASON
a) ASTM C227	Determine if alkali-silica reaction is likely to cause expansive reactions in Portland cement concrete. Consider cement with less than 0.6% (as sodium oxide) alkalie.
d) ASTM D1075	Determine effect of water on cohesion of compacted bituminous mixtures.
d) ASTM D1664	Test for coating and stripping of bituminous aggregate mixtures.

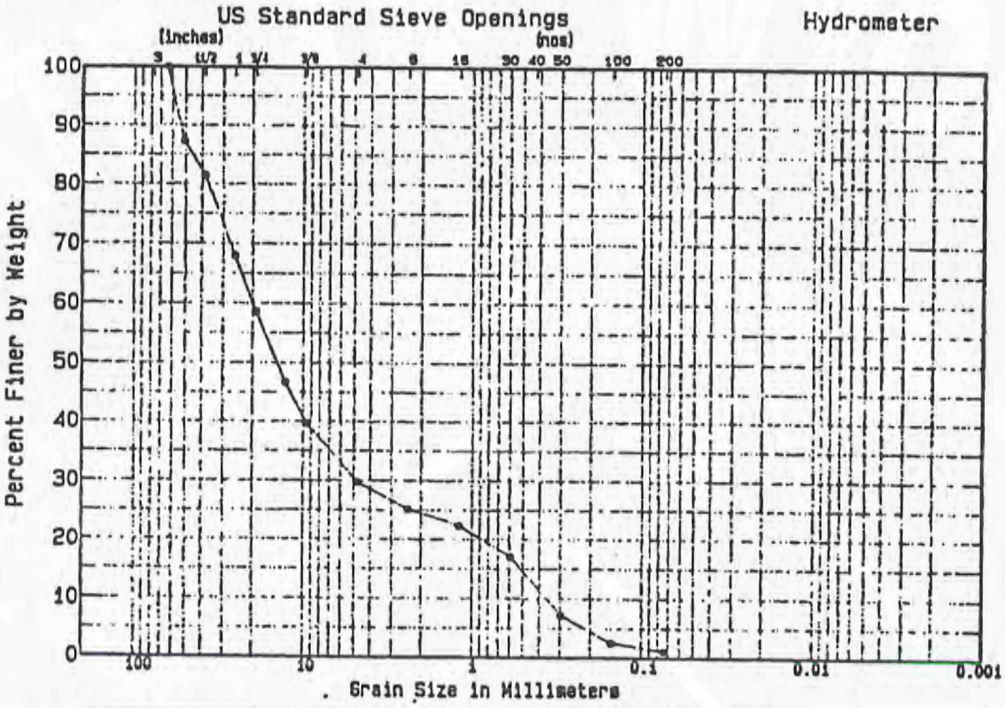
INBERG-MILLER ENGINEERS

Reviewed by Jon C. Howell P.E.

PARTICLE SIZE ANALYSIS

Project: AGGREGATE TESTING
Job No.: RM-2750-84
Client: BUREAU OF MINES

Test Date: 9-6-84
Tested By: SLF



Cobbles	Coarse Gravel	Fine Gravel	Coarse Sand	Medium Sand	Fine Sand	Silt	Clay

Unified Soil Classification System (ASTM D2487)

Sample No.: 16
Sampled By: CLIENT
Source: WIND RIVER RES.

Soil Description: DK. GRAYISH BROWN SANDY GRAVEL W/OCC. COBBLES

Percent Gravel: 70
Percent Sand: 29
Percent Silt & Clay: 1

Reviewed By: RLM
Date: 10-16-84

INBERG - MILLER ENGINEERS

APPENDIX C.--

Twenty-five reports by the U. S. Bureau of Reclamation on sand and gravel deposits in the vicinity of the Wind River Indian Reservation, Wyoming.

BIA report no.: BR 1

EL-251
(2-62)

ASSISTANT COMMISSIONER AND CHIEF ENGINEER
DIVISION OF ENGINEERING LABORATORIES
CONCRETE AND STRUCTURAL BRANCH

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION

STATE Wyoming	SOURCE NO. 2	AGGREGATE ~~RIPRAP~~	REPORT NO. C- 88 · DATE 5-30-40
LAT. 43° N	LONG. 108° W		LAB. SAMPLE NO. None · REG. 6
TYPE OF MATERIAL	Sand and gravel		DATE REC'D. 2-23-40
LTR. TRANSMITTAL	Superintendent		DATE 2-24-40
NAME OF DEPOSIT	Big Horn River		
LOCATION	At the site of proposed extension of Pilot Canal adjacent to Big Horn River		
SW 1/4 NW 1/4 SEC. 8	T 2 N	R 6 E	MERIDIAN Wind River
OWNERSHIP	Not furnished		
VOLUME	40,000 cubic yards	OVERBURDEN	3 feet
FEATURE	Pilot Canal Extension		
PROJECT	Riverton		COMPILED BY JDR
REMARKS			CHECKED BY RNH
			REVIEWED BY
			SUBMITTED BY

GRADING (DES. 4,5,6) (CUM. % RETAINED)

SIEVE	PIT RUN	3"-1½"	1½"-¾"	¾"-#4	FINE AGG.
8 IN.	0				
3 ½ IN.	--				
3 IN.	0				
2 ½ IN.	--				
1 ¾ IN.	--				
1 ½ IN.	0				
1 ¼ IN.	--				
⅞ IN.	--				
¾ IN.	44				
⅝ IN.	--				
⅜ IN.	84				
5/16 IN.	--				
NO. 4	100				0
NO. 5					--
NO. 8					15
NO. 16					30
NO. 30					47
NO. 50					74
NO. 100					92
PAN					100
F. M.	6.28				2.58
% SAND	40				

TEST RESULTS

	6"-3"	3-1½	1½"-¾"	~~xxxxx~~	~~xx~~-#4	FINE AGG.	WASHED FINE AGG.
SP. GR., S.S.D. (DES. 9, 10)	--	--		2.61		2.61	
ABSORPTION, PERCENT (DES. 9, 10)	--	--		1.2		1.4	
ORGANIC IMPURITIES, COLOR (DES. 14)	—	—	—	—	—	Clear	
PERCENT SILT (DES. 16)						2.9	
PERCENT LIGHTER THAN SP GR.							
CLAY LUMP, % (DES. 13)							
SAND EQUIVALENT	—	—	—	—	—		
Na_2SO_4 LOSS, 5 CYC WGTD % LOSS (DES. 19)	—	—		3.6		—	5.1
L.A. ABRASION (DES 21) GRADING	"A"	"B"		"C"		"D"	—
% LOSS, 100 REV.	Not tested						—
% LOSS 500 REV.							—

FREEZING AND THAWING DATA

CONCRETE							RIPRAP	
W/C RATIO	SLUMP INCHES	% AIR METER	H_2O LBS/YD^3	28-DAY STR. 3"x6" CYL	WGT. LOSS %	CYCLES	WGT. LOSS % 3 INCH CUBE	CYCLES
	Not tested							

ALKALI — AGGREGATE REACTIVITY DATA

MATERIALS	SAND				GRAVEL			
CEMENT NO.		Petro only				Petro only		
SODA EQUIVALENT								
TEST AGG %	100	100	80	25	100	100	80	25
EXP % — 6 MO								
EXP % — 12 MO								

PETROGRAPHIC DESCRIPTION: ~~XXXXXXXX~~ Report NO. C-88 DATE: 3-30-40 BY: W. Y. Holland

The gravels contain quartzite and similar siliceous rocks, mica schist, granite, andesite, rhyolite, basalt, and a few sedimentaries. The sands are essentially quartz with minor amounts of feldspars and other rock minerals. The gravels are well rounded with a slight tendency towards flatness. The sands are angular in form, the angularity increasing in the finer sizes. A small amount of the gravel and sand is unsound. Only a small amount of deleterious coating is present.

Conclusions: Aggregate comparable to the sample from the Big Horn River deposit is suitable for use in concrete provided proper gradings are obtained.

BIA report no.: BR 2

EL-251
(2-62)

ASSISTANT COMMISSIONER AND CHIEF ENGINEER
DIVISION OF ENGINEERING LABORATORIES
CONCRETE AND STRUCTURAL BRANCH

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION

STATE Wyoming	SOURCE NO. 17	AGGREGATE ~~RIPRAP~~	REPORT NO. C- 367 DATE 9-16-47
LAT. 43° N	LONG. 108° W		LAB. SAMPLE NO. 7389 REG. 6
TYPE OF MATERIAL	Sand and gravel		DATE REC'D. 11-19-46
LTR. TRANSMITTAL	Acting Project Engineer		DATE 11-13-46
NAME OF DEPOSIT	Paradise Valley Pit		
LOCATION	On Government land		
Secs 21, 22, ~~xx~~ 27, 28	T 2 N	R 4 E	MERIDIAN Wind River
OWNERSHIP	U.S. Government		
VOLUME	Not furnished	OVERBURDEN	Not furnished
FEATURE	Lost Wells Laterals and Wyoming Canal		
PROJECT	Missouri River Basin		COMPILED BY JDR
REMARKS			CHECKED BY RNH
			REVIEWED BY
			SUBMITTED BY

GRADING (DES. 4,5,6) (CUM. % RETAINED)

SIEVE	PIT RUN	3"		3-3/4	3/4-#4	Washed FINE AGG.
6 IN.						
3 1/2 IN.						
3 IN.				0		
2 1/2 IN.				--		
1 3/4 IN.				--		
1 1/2 IN.				4	0	
1 1/4 IN.				--	--	
7/8 IN.				--	--	
3/4 IN.				96	3	
5/8 IN.					--	
3/8 IN.					65	
5/16 IN.					--	
NO.4	0				100	0
NO.5	--					--
NO.8	11					1[illegible]
NO.16	31					3[illegible]
NO.30	59					5[illegible]
NO.50	87					8[illegible]
NO.100	96					9[illegible]
PAN	100					100
F.M.	2.84					2.8[illegible]
% SAND						

TEST RESULTS

	6"-3"	3-1 1/2	1 1/2-3/4	3/4-3/8	3/8-#4	FINE AGG.	WASHED FINE AGG.
SP. GR., S.S.D. (DES. 9, 10)	--	2.69	2.67	2.60	2.58	2.60	2.62
ABSORPTION, PERCENT (DES. 9, 10)	--	0.8	0.6	1.8	2.3	1.6	0.9
ORGANIC IMPURITIES, COLOR (DES. 14)	—	—	—	—	—	Clear	--
PERCENT SILT (DES. 16)						5.6	--
PERCENT LIGHTER THAN SP GR.							
CLAY LUMP, % (DES. 13)							
SAND EQUIVALENT	—	—	—	—	—		
NA_2SO_4 LOSS, 5 CYC WGTD % LOSS (DES. 19)	—	—	5.8			—	3.9

L.A. ABRASION (DES 21) GRADING	"A"	"B"	"C"	"D"	
% LOSS, 100 REV.	5.1				—
% LOSS 500 REV.	26.0				—

FREEZING AND THAWING DATA

CONCRETE							RIPRAP	
W/C RATIO	SLUMP INCHES	% AIR METER	H_2O LBS/YD³	28-DAY STR. 3"x6" CYL	WGT. LOSS %	CYCLES	WGT. LOSS % 3 INCH CUBE	CYCLES
	Not	tested						

ALKALI — AGGREGATE REACTIVITY DATA

MATERIALS	SAND				GRAVEL			
CEMENT NO.		Petro only				Petro only		
SODA EQUIVALENT								
TEST AGG %	100	100	50	25	100	100	50	25
EXP % — 6 MO								
EXP % — 12 MO								

PETROGRAPHIC DESCRIPTION: Report NO. C-367 DATE: 9-16-47 BY: L. C. Zima

The gravel is subangular in shape and is composed mainly of andesite porphyries, basalts, granites, granite gneisses, quartzites, and chert with small amounts of sandstones, limestones, and andesites. Physically unsound materials constitute 23.5 percent and deleteriously reactive particles 18.9 percent of the gravel.

The sand is predominantly subangular in shape and is composed mainly of feldspar, granite, quartz, chert, quartzite, and chalcedony. Physically unsound particles constitute 5 to 10 percent of the sand.

Conclusions: Aggregate comparable to Sample No. 7389 is suitable for use in concrete provided the sand is washed to remove excess silt, proper gradings are obtained, and low-alkali cement is used.

BIA report no.: BR 3

EL-251
(2-62)

ASSISTANT COMMISSIONER AND CHIEF ENGINEER
DIVISION OF ENGINEERING LABORATORIES
CONCRETE AND STRUCTURAL BRANCH

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION

AGGREGATE ~~RIPRAP~~

STATE	Wyoming
SOURCE NO.	35
REPORT NO. C-	978
DATE	4-3-61
LAT.	43° N
LONG.	108° W
LAB. SAMPLE NO. M-	3708
REG.	6
TYPE OF MATERIAL	Sand and gravel
DATE REC'D.	3-23-60
LTR. TRANSMITTAL	Project Manager, Riverton, Wyoming
DATE	3-22-60
NAME OF DEPOSIT	Airport Bench Pit
LOCATION	
SEC.	11
T	1 N
R	3 E
MERIDIAN	Wind River
OWNERSHIP	Not furnished
VOLUME	Not furnished
OVERBURDEN	Not furnished
FEATURE	Midvale Irrigation Rehabilitation and Betterment
PROJECT	Riverton, Wyoming
REMARKS	
COMPILED BY	RNH
CHECKED BY	JDR
REVIEWED BY	
SUBMITTED BY	

GRADING (DES. 4,5,6) (CUM. % RETAINED)

SIEVE	PIT RUN	3–1½	1½–¾	¾–#4	Washed FINE AGG.
6 IN.					
3½ IN.					
3 IN.					
2½ IN.					
1¾ IN.				1	
1½ IN.				5	
1¼ IN.				13	
7/8 IN.				--	
¾ IN.				33	
5/8 IN.				--	
3/8 IN.				76	
5/16 IN.				--	
NO. 4	1			99	1
NO. 5	--			100	--
NO. 8	7				7
NO. 16	13				14
NO. 30	24				25
NO. 50	61				64
NO. 100	90				93
PAN	100				100
F. M.	1.96				204
% SAND					

TEST RESULTS

	6"–3"	3–1½	1½–¾	¾–3/8	3/8–#4	FINE AGG.	WASHED FINE AGG.
SP. GR., S.S.D. (DES. 9, 10)	--	--	2.59	2.59	2.59	2.62	2.61
ABSORPTION, PERCENT (DES. 9, 10)	--	--	1.3	1.5	1.7	1.4	1.3
ORGANIC IMPURITIES, COLOR (DES. 14)	—	—	—	—	—	Clear	
PERCENT SILT (DES. 16)						4.6	
PERCENT LIGHTER THAN SP GR.							
CLAY LUMP, % (DES. 13)							
SAND EQUIVALENT	—	—	—	—	—	79	95
Na_2SO_4 LOSS, 5 CYC WGTD % LOSS (DES. 19)	—	—	1.9			—	3.1

L.A. ABRASION (DES 21) GRADING	"A"	"B"	"C"	"D"	
% LOSS, 100 REV.		3.9			—
% LOSS 500 REV.		20.7			—

FREEZING AND THAWING DATA

CONCRETE W/C RATIO	SLUMP INCHES	% AIR METER	H_2O LBS/YD^3	28-DAY STR. 3"x6" CYL.	WGT. LOSS %	CYCLES	RIPRAP WGT. LOSS % 3 INCH CUBE	RIPRAP CYCLES
0.51	3.6	4.2	269	3,520	25	620		

ALKALI — AGGREGATE REACTIVITY DATA

MATERIALS	SAND				GRAVEL			
CEMENT NO.		Petro only				Petro only		
SODA EQUIVALENT								
TEST AGG %	100	100	50	25	100	100	50	25
EXP % — 6 MO								
EXP % — 12 MO								

PETROGRAPHIC DESCRIPTION: MEMORANDUM NO. 60-37 DATE: 5-9-60 BY: C. A. Bechtold

The gravel particles are subrounded to flattened in shape and are composed of andesite, tuff, andesitic basalt, quartzite, schist and gneiss, granite, and some sandstone, chert, and rhyolite. Physically unsound particles constitute about 1 percent and fair physical quality particles constitute about 35 percent of the gravel. Deleteriously reactive particles constitute about 47 percent of the gravel.

The sand particles range in shape from subangular to angular and are composed predominantly of the same rock types present in the gravel. Physically unsound particles constitute about 5 percent of the sand. Rock types known to be deleteriously reactive with high-alkali cement constitute about 18 percent of the analyzed sand.

Conclusions: The specific gravity of the gravel tested is marginal with respect to usual specifications limits; however, sand and gravel comparable to Sample No. M-3708 are suitable for use in concrete provided proper gradings are obtained, the sand is washed to remove excess silt, and low-alkali cement is used.

BIA report no.: BR 4

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION

CONCRETE AND STRUCTURAL BRANCH
DIVISION OF GENERAL RESEARCH
ENGINEERING AND RESEARCH CENTER
DENVER, COLORADO 80225
DATE............

AGGREGATE
~~[illegible]~~
QUALITY EVALUATION

BRANCH FILE NO. C-....................
COMPILED BY....................
CHECKED BY....................
REVIEWED BY....................
SUBMITTED BY....................

STATE Wyoming	REG. UM	SOURCE NO. 38	LAT. 43°N	LONG. 108°W
SAMPLE NO. M-7166	MATERIAL Sand and gravel			DATE REC'D. 9-28-79
DEPOSIT NAME Gilpatrick Construction Company, Inc.			OVERBURDEN 1-4 feet	
OWNERSHIP Gilpatrick Construction Company, Inc.			VOLUME 400 acres *	
LOCATION Pit located in W½NW¼ SEC. 8	T 1 N	R 4 E	MERIDIAN Wind River	
FEATURE Various Features - Riverton Unit				
PROJECT Pick-Sloan Missouri Basin Program				
REMARKS * Gravel deposit in secs. 7 and 8, T 1 N, R 4 E, and sec. 12, T 1 N, R 3 E, Wind River meridian			DATE LTR. TRANS. 9-25-79	

GRADING (DES. 4,5,6) CUM. % RETAINED

SIEVE	PIT RUN	3"-1½"	1½"-¾"	¾"-#4	FINE AGG.	WASHED FINE AGG.
6 IN						
3½ IN						
3 IN						
2½ IN						
1¾ IN						
1½ IN						
1¼ IN						
7/8 IN						
¾ IN						
5/8 IN						
3/8 IN						
5/16 IN						
NO. 4					0	0
NO. 5					–	–
NO. 8					16	18
NO. 16					30	33
NO. 30					43	46
NO. 50					69	73
NO. 100					88	92
PAN					100	100
F.M.		——			2.46	2.62
% SAND		——				

TEST RESULTS

	6"-3"	3"-1½"	1½"-¾"	¾"-3/8"	3/8"-#4	FINE AGG	WASHED FINE AGG
SP. GR., S.S.D. (DES. 9,10)		2.66	2.61	2.61	2.59		2.58
ABSORPTION, % (DES. 9,10)		0.3	1.0	1.2	1.8		1.9
ORGANIC IMPURITIES, (DES. 14)	—	—	—	—	—	No. 2	
PERCENT SILT (DES. 16)						7.7	
% LIGHTER - SP.GR. (DES. 17,18,42)							
FRIABLE PARTICLES, % (DES. 13)							
SAND EQUIVALENT	—	—	—	—	—		
NA_2SO_4 LOSS, 5 CYC. WGT'D. % LOSS (DES. 19)				4		—	8

L.A. ABRASION (DES. 21) GRADING	"A"	"B"	"C"	"D"
% LOSS, 100 REV.	5			
% LOSS, 500 REV.	23			

FREEZING AND THAWING DATA

CONCRETE							RIPRAP	
W/C RATIO	SLUMP INCHES	% AIR METER	H_2O LBS/YD³	28-DAY STRENGTH 3"x6" CYL'S.	WEIGHT LOSS, %	CYCLES	WEIGHT LOSS, % 3 INCH CUBE	CYCLES
0.51	3.0	6.1	269	3350	12	1000		

ALKALI-AGGREGATE REACTIVITY DATA

MATERIALS	SAND				GRAVEL			
CEMENT NO.		Not tested				Not tested		
SODA EQUIVALENT								
TEST AGG. %	100	100	50	25	100	100	50	25
EXP % - 6 MO.								
EXP % - 12 MO.								

PETROGRAPHIC DESCRIPTION: MEMORANDUM NO. 80-45 DATE: 6-30-80 BY: S. B. Willcut

The gravel, mostly angular in shape with about 39 percent rounded, 25 percent flat and/or elongated and 23 percent moderately well-bonded calcium carbonate and sand grain coated particles, is composed primarily of glassy volcanics with lesser amounts of quartzite, gneiss, granitic-type rocks, chert and basalt. Less than 1 percent physically unsound and about 70 percent potentially alkali-reactive glassy volcanic and chert particles are present.

The sand, angular to rounded in shape, is composed of decreasing amounts of the fine-grained rock types found in the gravel and increasing amounts of monomineralic grains of quartz, feldspar, hornblende, biotite, pyroxene, magnetite, clay, calcite, and iron oxide as will as volcanic glass shards and a few miscellaneous detrital minerals in the finer sizes. About 8 percent physically unsound and 37 percent potentialy alkali-reactive glassy volcanic and chert particles are present in the coarse sand.

Conclusions: Although the sand specific gravity is marginal, aggregate comparable to sample No. M-7166 is suitable for use in concrete provided the sand is washed to remove excess silt, proper gradings are obtained, and low-alkali cement is used.

BIA report no.: BR 5

EL-EM 8-71
Bureau of Reclamation

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION

CONCRETE AND STRUCTURAL BRANCH
DIVISION OF GENERAL RESEARCH
ENGINEERING AND RESEARCH CENTER
DENVER, COLORADO 80225
DATE March 1978

AGGREGATE
~~XXXXXX~~
QUALITY EVALUATION

BRANCH FILE NO. C- 367D
COMPILED BY
CHECKED BY
REVIEWED BY
SUBMITTED BY

STATE Wyoming	REG. 1TM	SOURCE NO. 37	LAT. 43° N / LONG. 108° W
SAMPLE NO. M-6782A	MATERIAL Sand and gravel (processed)		DATE REC'D. 10-26-76
DEPOSIT NAME Turner Redi-Mix Concrete, Inc.			OVERBURDEN 0-0.8m (2.5 ft)
OWNERSHIP Turner Redi-Mix Concrete, Inc.			VOLUME *
LOCATION Fluvial deposit adjacent to west side of Wind River in SE1/4NE1/4 and NE1/4SE1/4 of	SEC. 23	T 1 N, R 4 E	MERIDIAN Wind River
FEATURE Various features - Riverton Unit			
PROJECT Pick-Sloan Missouri Basin Program			
REMARKS *Deposit (partially removed) covers area 0.8km (0.5 mi) long by 152m - (500 ft) wide with depth of 4.6m (15 ft)			DATE LTR. TRANS. 10-22-76

GRADING (DES. 4,5,6) CUM. % RETAINED

SIEVE	PIT RUN	3"-1½"	1½"-¾"	¾"-#4	FINE AGG.	WASHED FINE AGG
6 IN.						
3½ IN.						
3 IN.	Commercial deposit -					
2½ IN.	gravel grading					
1¾ IN.	not performed					
1½ IN.						
1¼ IN.						
7/8 IN.						
¾ IN.						
5/8 IN.						
3/8 IN.						
5/16 IN.						
NO. 4					2	
NO. 8					-	
NO. 8					15	
NO. 16					25	
NO. 30					39	
NO. 50					77	
NO. 100					96	
PAN					100	
F.M.		—	—	—	2.54	
% SAND		—	—	—	—	

TEST RESULTS

	6"-3"	3"-1½"	1½"-¾"	¾"-3/8"	3/8"-#4	FINE AGG.	WASHED FINE AGG.
SP. GR., S.S.D. (DES. 9,10)			2.60	2.61	2.60	2.60	
ABSORPTION, % (DES. 9,10)			1.3	1.5	1.6	1.5	
ORGANIC IMPURITIES, (DES. 14)	—	—	—	—	—	clear	
PERCENT SILT (DES. 16)						2.1	
% LIGHTER - SP.GR. (DES. 17,18,42)							
CLAY LUMPS, % (DES. 13)							
SAND EQUIVALENT	—	—	—	—	—		
NA_2SO_4 LOSS, 5 CYC. WGT'D % LOSS (DES. 19)				5		—	5

L.A. ABRASION (DES. 21) GRADING	"A"	"B"	"C"	"D"
% LOSS, 100 REV.		4		
% LOSS, 500 REV.		20		

FREEZING AND THAWING DATA

CONCRETE W/C RATIO	SLUMP INCHES	% AIR METER	H_2O LBS/YD³	28-DAY STRENGTH 3"x6" CYLS.	WEIGHT LOSS, %	CYCLES	RIPRAP WEIGHT LOSS, % 3 INCH CUBE	CYCLES
0.51	3.3	5.3	260	4,720	25	1,090		

ALKALI-AGGREGATE REACTIVITY DATA

MATERIALS	SAND				GRAVEL			
CEMENT NO.	Not tested				Not tested			
SODA EQUIVALENT								
TEST AGG., %	100	100	50	25	100	100	50	25
EXP % - 6 MO.								
EXP % - 12 MO.								

PETROGRAPHIC DESCRIPTION: MEMORANDUM NO. 76-47 DATE: 11-15-76 BY: L. A. Bechtold

The gravel, essentially subround with about 30 percent subangular, about 17 percent flat and about 16 percent calcium carbonate, sand grain and opal coated, is composed essentially of glassy and altered volcanics (andesite), basalt, granite, and quartzite with lesser amounts of epidote rock and chert. About 1 percent physically unsound and about 34 percent alkali-reactive rock types, glassy volcanics (andesite) and chert, were seen. The sand, subround to angular in shape, is composed of the same rock types found in the gravel with increasing amounts of monomineralic grains of quartz, feldspar, amphibole, mica, garnet, epidote, magnetite, and a few miscellaneous detrital minerals in the finer sizes. About 10 percent of the coarse sand is physically unsound and about 15 percent alkali-reactive rock types were seen.

Conclusions: Aggregate comparable to sample No. M-6782A is suitable for use in concrete provided proper gradings are obtained and low-alkali cement is used.

BIA report no.: BR 6

EL-251
(2-62)

ASSISTANT COMMISSIONER AND CHIEF ENGINEER
DIVISION OF ENGINEERING LABORATORIES
CONCRETE AND STRUCTURAL BRANCH

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION

AGGREGATE ~~RIPRAP~~

STATE Wyoming	SOURCE NO. 33	AGGREGATE ~~RIPRAP~~	REPORT NO. C- 939	DATE 3-29-60	
LAT. 43° N	LONG. 108° W		LAB. SAMPLE NO. M- 3533		REG. 6
TYPE OF MATERIAL	Sand		DATE REC'D. 7-24-59		
LTR. TRANSMITTAL	Construction Engineer, Cody, Wyoming			DATE 7-23-59	
NAME OF DEPOSIT	M. J. Gilpatrick				
LOCATION	SEC. 25	T 1 N	R 4 E	MERIDIAN Wind River	
OWNERSHIP	M. J. Gilpatrick				
VOLUME	Not furnished		OVERBURDEN Not furnished		
FEATURE	Pilot Butte Switchyard--Schedule No. 2--Specifications No. DC-5190				
PROJECT	Transmission Division--Missouri River Basin		COMPILED BY RNH		
REMARKS	*F&T mix was made using 50-50 blend of		CHECKED BY JDR		
	plus No. 16 sand from Samples No. M-3533 and 3534		REVIEWED BY		
	to obtain an FM of 2.74. M-3534 gravel used in mix.		SUBMITTED BY		

GRADING (DES. 4,5,6) (CUM. % RETAINED)

SIEVE	PIT RUN	3"-1½"	1½"-¾"	¾"-#4	FINE AGG.
6 IN.					
3½ IN.					
3 IN.					
2½ IN.					
1¾ IN.					
1½ IN.					
1¼ IN.					
⅞ IN.					
¾ IN.					
⅝ IN.					
⅜ IN.					
5/16 IN.					
NO. 4					2
NO. 5					--
NO. 8					14
NO. 16					30
NO. 30					51
NO. 50					82
NO. 100					97
PAN					100
F. M.					2.76
% SAND					

TEST RESULTS

	6"-3"	3-1½	1½-¾	¾-⅜	⅜-#4	FINE AGG.	WASHED FINE AGG.
SP. GR., S.S.D. (DES. 9, 10)						2.64	
ABSORPTION, PERCENT (DES. 9, 10)						0.6	
ORGANIC IMPURITIES, COLOR (DES. 14)	—	—	—	—	—	Clear	
PERCENT SILT (DES. 16)						2.4	
PERCENT LIGHTER THAN SP GR.							
CLAY LUMP, % (DES. 13)							
SAND EQUIVALENT	—	—	—	—	—		
Na_2SO_4 LOSS, 5 CYC WGTD % LOSS (DES. 19)	—	—				—	2.8
L.A. ABRASION (DES 21) GRADING	"A"	"B"	"C"	"D"			—
% LOSS, 100 REV.							—
% LOSS 500 REV.							—

FREEZING AND THAWING DATA *

CONCRETE							RIPRAP	
W/C RATIO	SLUMP INCHES	% AIR METER	H_2O LBS/YD³	28-DAY STR. 3"x6" CYL.	WGT. LOSS %	CYCLES	WGT. LOSS % 3 INCH CUBE	CYCLES
0.51	3.3	4.3	283	4,220	25	930		

ALKALI — AGGREGATE REACTIVITY DATA

MATERIALS	SAND				GRAVEL			
CEMENT NO.		Petro only						
SODA EQUIVALENT								
TEST AGG %	100	100	80	25	100	100	80	25
EXP % — 6 MO								
EXP % — 12 MO								

PETROGRAPHIC DESCRIPTION: MEMORANDUM NO. 59-85 DATE: 8-13-59 BY: C. A. Bechtold

Sand particles varied from subangular to almost angular in shape and are composed of sedimentary rock types, including sandstone, quartzite, silicified limestone, chert, and limestone with individual mineral grains of quartz, feldspar, amphibole, pyroxene, mica, garnet, chert, iron oxides, and chlorite.

Physically unsound particles constitute about 9 percent and particles of deleteriously reactive material about 10 percent of the sand examined.

Conclusions: Sand comparable to Sample No. M-3533 is not of first quality but is suitable for use in concrete provided proper gradings are obtained and specification low-alkali cement is used.

BIA report no.: BR 7

EL-251
(2-52)

ASSISTANT COMMISSIONER AND CHIEF ENGINEER
DIVISION OF ENGINEERING LABORATORIES
CONCRETE AND STRUCTURAL BRANCH

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION

STATE	Wyoming	SOURCE NO.	16	AGGREGATE ~~RIPRAP~~	REPORT NO. C-	334	DATE 1-30-47
LAT.	43° N	LONG.	108° W		LAB. SAMPLE NO.	7247	REG. 6
TYPE OF MATERIAL	Sand and gravel				DATE REC'D.	8-26-46	
LTR TRANSMITTAL	Superintendent						DATE 8-23-46
NAME OF DEPOSIT	Gilpatrick Pit						
LOCATION	Near Riverton, Wyoming in						
N 1/2, NW 1/4	SEC. 33	T 1 N	R 4 E		MERIDIAN	Wind River	
OWNERSHIP	M. J. Gilpatrick (Operator)						
VOLUME	40,000 cubic yards		OVERBURDEN		Not furnished		
FEATURE	Lost Wells Lateral System--Specifications No. 1284						
PROJECT	Riverton				COMPILED BY	JDR	
REMARKS					CHECKED BY	RNH	
					REVIEWED BY		
					SUBMITTED BY		

GRADING (DES. 4,5,6) (CUM. % RETAINED)

SIEVE	PIT RUN	3"-1½"	1½"-¾"	¾"-#4	FINE AGG.
6 IN.					
3½ IN.					
3 IN.					
2½ IN.					
1¾ IN.					
1½ IN.					
1¼ IN.					
⅞ IN.				1	
¾ IN.				17	
⅝ IN.				--	
⅜ IN.				80	
5/16 IN.				--	--
NO. 4				99	0
NO. 5				100	--
NO. 8					11
NO. 16					26
NO. 30					45
NO. 50					80
NO. 100					96
PAN					100
F.M.					2.58
% SAND					

TEST RESULTS

	6"-3"	3-1½	1½-¾	¾-⅜	⅜-#4	FINE AGG.	WASHED FINE AGG.
SP. GR., S.S.D. (DES. 9, 10)	--	--	2.63	2.63	2.62	2.62	
ABSORPTION, PERCENT (DES. 9, 10)	--	--	1.0	1.2	1.3	1.2	
ORGANIC IMPURITIES, COLOR (DES. 14)	—	—	—	—	—	No. 1	
PERCENT SILT (DES. 16)						1.8	
PERCENT LIGHTER THAN SP GR.							
CLAY LUMP, % (DES. 13)							
SAND EQUIVALENT	—	—	—	—	—		
Na_2SO_4 LOSS, 5 CYC WGTD % LOSS (DES. 19)	—	—		4.0		—	7.5

L.A. ABRASION (DES 21) GRADING	"A"	"B"	"C"	"D"	
% LOSS, 100 REV.	--	5.2			—
% LOSS 500 REV.	--	22.9			—

FREEZING AND THAWING DATA

CONCRETE: W/C RATIO	SLUMP INCHES	% AIR METER	H_2O LBS/YD³	28-DAY STR. 3"x6" CYL	WGT. LOSS %	CYCLES	RIPRAP: WGT. LOSS % 3 INCH CUBE	CYCLES
	Not tested							

ALKALI - AGGREGATE REACTIVITY DATA

MATERIALS	SAND				GRAVEL			
CEMENT NO.	Petro only				Petro only			
SODA EQUIVALENT								
TEST AGG %	100	100	50	25	100	100	50	25
EXP % - 6 MO								
EXP % - 12 MO								

PETROGRAPHIC DESCRIPTION: ~~XXXXXXXXX~~ Report NO. C-334 DATE: 1-30-47 BY: M. E. King

The gravel ranges in shape from subangular to subround and is composed of basalts, rhyolites, andesite porphyries, quartzites, and granites with smaller proportions of limestones, diorites, and cherts. Physically unsound material constitutes about 2.3 percent and materials known to be chemically reactive with high-alkali cements constitute about 14.6 percent of the gravel.

The coarse sand particles are predominantly angular and the finer fractions range from subangular to subround in shape. The coarse fractions of the sand are similar lithologically to the gravel, but the finer fractions are composed predominantly of quartz, feldspars, and hornblende with smaller amounts of various rock types. Physically unsound particles constitute 2 to 3 percent and chert occurs sparsely in the sound.

Conclusions: Aggregate comparable to Sample No. 7247 is suitable for use in concrete provided proper gradings are obtained and low-alkali cement is used.

BIA report no.: BR 8

EL-251 (2-62)

ASSISTANT COMMISSIONER AND CHIEF ENGINEER
DIVISION OF ENGINEERING LABORATORIES
CONCRETE AND STRUCTURAL BRANCH

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION

AGGREGATE ~~RIPRAP~~

STATE	Wyoming
SOURCE NO.	34
LAT.	43° N
LONG.	108° W
REPORT NO. C-	939
DATE	3-29-60
LAB. SAMPLE NO. M-	3534
REG.	6
TYPE OF MATERIAL	Sand and gravel
DATE REC'D.	7-24-59
LTR. TRANSMITTAL	Construction Engineer, Cody, Wyoming
DATE	7-23-59
NAME OF DEPOSIT	H. J. Chopping
LOCATION	Lot 5
SEC.	31
T	1 N
R	4 E
MERIDIAN	Wind River
OWNERSHIP	H. J. Chopping
VOLUME	Not furnished
OVERBURDEN	Not furnished
FEATURE	Pilot Butte Switchyard--Schedule No. 2--Specifications No. DC-5190
PROJECT	Transmission Division--Missouri River Basin
COMPILED BY	RNH
CHECKED BY	JDR
REVIEWED BY	
SUBMITTED BY	
REMARKS	~~*F&T mix was made using 50-50 blend of plus No. 16 sand from Samples No. M-3533 and 3534 to obtain an FM of 2.74.~~

GRADING (DES. 4,5,6) (CUM. % RETAINED)

SIEVE	PIT RUN	3"-1½"	1½"-¾"	¾"-#4	Washed FINE AGG.
6 IN.					
3½ IN.					
3 IN.					
2½ IN.					
1¾ IN.			0		
1½ IN.			1		
1¼ IN.			6		
⅞ IN.			--	0	
¾ IN.			84	0	
⅝ IN.			96	--	
⅜ IN.				79	
5/16 IN.				--	
NO. 4	0			99	0
NO. 5	--				--
NO. 8	3				[illegible]
NO. 16	10				1[illegible]
NO. 30	32				3[illegible]
NO. 50	77				8[illegible]
NO. 100	94				9[illegible]
PAN	100				100
F.M.	2.16				2.2[illegible]
% SAND					

TEST RESULTS

	6"-3"	3-1½	1½-¾	¾-⅜	⅜-#4	FINE AGG.	WASHED FINE AGG.
SP. GR., S.S.D. (DES. 9, 10)	--	--	2.65	2.63	2.62	2.62	2.62
ABSORPTION, PERCENT (DES. 9, 10)	--	--	0.6	0.9	1.1	0.8	0.6
ORGANIC IMPURITIES, COLOR (DES. 14)	—	—	—	—	—	Clear	
PERCENT SILT (DES. 16)						4.2	
PERCENT LIGHTER THAN SP GR.							
CLAY LUMP, % (DES. 13)							
SAND EQUIVALENT	—	—	—	—	—		
Na_2SO_4 LOSS, 5 CYC WGTD % LOSS (DES. 19)	—	—	2.8			—	5.9

L.A. ABRASION (DES 21) GRADING	"A"	"B"	"C"	"D"	
% LOSS, 100 REV.	4.1				—
% LOSS 500 REV.	22.8				—

FREEZING AND THAWING DATA *

CONCRETE							RIPRAP	
W/C RATIO	SLUMP INCHES	% AIR METER	H_2O LBS/YD³	28-DAY STR. 3"x6" CYL.	WGT. LOSS %	CYCLES	WGT. LOSS % 3 INCH CUBE	CYCLES
0.51	3.3	4.3	283	4,220	25	930		

ALKALI — AGGREGATE REACTIVITY DATA

MATERIALS	SAND				GRAVEL			
CEMENT NO.		Petro only				Petro only		
SODA EQUIVALENT								
TEST AGG %	100	100	80	25	100	100	80	25
EXP % — 6 MO								
EXP % — 12 MO								

PETROGRAPHIC DESCRIPTION: MEMORANDUM NO. 59-85 DATE: 8-13-59 BY: C. A. Bechtold

Gravel particles varied from subrounded to subangular and are composed of sedimentary rock types, including sandstone, quartzite, silicified limestone, chert, and limestone. Physically unsound particles constitute less than 1 percent of the particles examined and deleteriously reactive material about 37 percent.

Sand particles varied from subangular to almost angular in shape and are composed of the same rock types that occur in the gravels with individual mineral grains of quartz, feldspar, amphibole, pyroxene, mica, garnet, chert, iron oxides, and chlorite. Physically unsound particles constitute about 6 percent and particles of deleteriously reactive material about 20 percent of the sand.

Conclusions: Sand and gravel comparable to Sample No. M-3534 are suitable for use in concrete provided the sand is washed to remove excess silt, proper gradings are obtained, and specification (low-alkali) cement is used.

BIA report no.: BR 9

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION

CONCRETE AND STRUCTURAL BRANCH
DIVISION OF GENERAL RESEARCH
ENGINEERING AND RESEARCH CENTER
DENVER, COLORADO 80225

AGGREGATE QUALITY EVALUATION

DATE May 1977

BRANCH FILE NO. C- 367C
COMPILED BY
CHECKED BY
REVIEWED BY
SUBMITTED BY

IMPORTANT NOTICE

Information contained in this data sheet regarding commercial products may not be used for advertising or promotional purposes and is not to be construed as an endorsement of any product by the Bureau of Reclamation.

STATE Wyoming	REG. UM	SOURCE NO. 2	LAT. 42° N / LONG. 108° W
SAMPLE NO. M-6687B	MATERIAL Processed sand and gravel		DATE REC'D. 9-24-75
DEPOSIT NAME Lander Ready-Mix			OVERBURDEN 0-3 m (0-10 ft)
OWNERSHIP Lander Ready-Mix, Lander, Wyoming			VOLUME 49 ha; 15 m deep*
LOCATION Adjacent to west side of Popo Agie River on Wind River Indian Reservation			
N1/2 SEC. 30	T 2 S	R 2 E	MERIDIAN Wind River
FEATURE Wyoming Canal - Riverton Unit - Specifications No. 617C-98			
PROJECT Pick-Sloan Missouri Basin Program			
REMARKS *(120 acres, 50 ft deep)			
			DATE LTR. TRANS. 9-24-75

GRADING (DES. 4, 5, 6) CUM. % RETAINED

SIEVE	PIT RUN	3"-1½"	1½"-¾"	¾"-#4	FINE AGG.	WASHED FINE AGG.
6 IN.						
3½ IN.						
3 IN.	Commercial deposit - gravel grading not performed					
2½ IN.						
1¾ IN.						
1½ IN.						
1¼ IN.						
7/8 IN.						
3/4 IN.						
5/8 IN.						
3/8 IN.						
5/16 IN.						
NO. 4					3	3
NO. 5					–	–
NO. 8					18	18
NO. 16					34	34
NO. 30					57	58
NO. 50					80	81
NO. 100					93	94
PAN					100	100
F.M.		———			2.85	2.88
% SAND		———				

TEST RESULTS

	6"-3"	3"-1½"	1½"-¾"	¾"-⅜"	⅜"-#4	FINE AGG.	WASHED FINE AGG.
SP. GR., S.S.D. (DES. 9, 10)			2.62	2.60	2.59		2.63
ABSORPTION, % (DES. 9, 10)			1.3	2.0	2.2		1.4
ORGANIC IMPURITIES, (DES. 14)	—	—	—	—	—	clear	
PERCENT SILT (DES. 16)						3.2	
% LIGHTER - SP. GR. (DES. 17, 18, 42)							
CLAY LUMPS, % (DES. 13)							
SAND EQUIVALENT	—	—	—	—	—		
NA_2SO_4 LOSS, 5 CYC. WGT'D % LOSS (DES. 19)			8			—	7

L.A. ABRASION (DES. 21) GRADING	"A"	"B"	"C"	"D"
% LOSS, 100 REV.	10			
% LOSS, 500 REV.	35			

FREEZING AND THAWING DATA

CONCRETE 1/							RIPRAP	
W/C RATIO	SLUMP INCHES	% AIR METER	H_2O LBS/YD³	28-DAY STRENGTH 3"x6" CYL'S	WEIGHT LOSS, %	CYCLES	WEIGHT LOSS, % 3 INCH CUBE	CYCLES
0.51	2.8	5.4	276	3,330	25	755		

ALKALI-AGGREGATE REACTIVITY DATA

MATERIALS	SAND				GRAVEL			
CEMENT NO.		Not tested				Not tested		
SODA EQUIVALENT								
TEST AGG. %	100	100	50	25	100	100	50	25
EXP % - 6 MO.								
EXP % - 12 MO.								

PETROGRAPHIC DESCRIPTION: MEMORANDUM NO. 75-48 DATE: 10-21-75 BY: C. A. Bechtold

The gravel, essentially subangular with about 31 percent subround and 23 percent flat particles as well as 5 percent coated with a calcium carbonate and sand grain coating moderately well bonded to the particle surface, is composed essentially of granite, limestone, siltstone, and sandstone with lesser amounts of ferruginous particles and chert. About 2 percent of the gravel is physically unsound and about 1 percent alkali-reactive rock types (chert) are present. The sand, almost round to angular in shape with about 10 percent flat particles, is composed of decreasing amounts of the same rock types found in the coarse sand and increasing amounts of monomineralic grains of quartz, feldspar, amphibole, mica, epidote, garnet, magnetite, and a few miscellaneous detrital minerals. About 6 percent of the sand is physically unsound and less than 1 percent (about 0.33 percent) alkali-reactive rock types were seen.

Conclusions: Aggregate comparable to sample No. M-6687B is suitable for use in concrete provided the sand is washed to remove excess silt and proper gradings are obtained.

1/Compressive strength of concrete made with this aggregate is 19 percent below a laboratory established average of 4,100 psi at 28 days' age for concretes made with a 0.51 w/c ratio and 3/4-inch MSA from over 400 different sources.

BIA report no.: BR 10

EL-251
(2-62)

ASSISTANT COMMISSIONER AND CHIEF ENGINEER
DIVISION OF ENGINEERING LABORATORIES
CONCRETE AND STRUCTURAL BRANCH

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION

STATE Wyoming	SOURCE NO. 1	AGGREGATE	REPORT NO. C- 567 — DATE 4-16-1951
LAT. 42° N	LONG. 109° W		LAB. SAMPLE NO. M- 893 — REG. 6
TYPE OF MATERIAL	Sand		DATE REC'D. 8-30-1950
LTR. TRANSMITTAL	District Engineer		DATE 8-21-1950
NAME OF DEPOSIT	Raft Lake		
LOCATION	At Raft Lake, 20 miles west of Wind River, Wyoming		
about W 1/2 SEC. 8	T 1 S	R 4 W	MERIDIAN Wind River
OWNERSHIP	Shoshone Indian Reservation		
VOLUME	165,000 cubic yards	OVERBURDEN	Not Furnished
FEATURE	Raft Lake Dam		
PROJECT	Missouri River Basin		COMPILED BY JDR
REMARKS	*Approximately 5 percent of this sample was retained on the No. 4 screen. This was an insufficient amount for testing.		CHECKED BY RNH
			REVIEWED BY
			SUBMITTED BY

GRADING (DES. 4,5,6) (CUM. % RETAINED)

SIEVE	PIT RUN	3"-1½"	1½"-¾"	¾"-No.4	FINE AGG.
6 IN.					
3½ IN.					
3 IN.					
2½ IN.					
1¾ IN.					
1½ IN.					
1¼ IN.					
⅞ IN.					
¾ IN.					
⅝ IN.					
⅜ IN.					
5/16 IN.					
NO. 4				*	0
NO. 5					--
NO. 8					7
NO. 16					26
NO. 30					60
NO. 50					89
NO. 100					99
PAN					100
F. M.					2.81
% SAND					

TEST RESULTS

	6"-3"	3-1½	1½-¾	¾-⅜	⅜-No.4	FINE AGG.	WASHED FINE AGG.
SP. GR., S.S.D. (DES. 9, 10)						2.65	
ABSORPTION, PERCENT (DES. 9, 10)						0.7	
ORGANIC IMPURITIES, COLOR (DES. 14)	—	—	—	—	—	#2	
PERCENT SILT (DES. 16)						0.7	
PERCENT LIGHTER THAN SP GR.							
CLAY LUMP, % (DES. 13)							
SAND EQUIVALENT	—	—	—	—	—		
Na_2SO_4 LOSS, 5 CYC WGTD % LOSS (DES. 19)	—	—				—	3.7

L.A. ABRASION (DES 21) GRADING	"A"	"B"	"C"	"D"	
% LOSS, 100 REV.					—
% LOSS 500 REV.					—
					—

FREEZING AND THAWING DATA

CONCRETE: W/C RATIO	SLUMP INCHES	% AIR METER	H_2O LBS/YD³	28-DAY STR. 3"x6" CYL	WGT. LOSS %	CYCLES	RIPRAP: WGT. LOSS % 3 INCH CUBE	CYCLES
	Not Tested							

ALKALI—AGGREGATE REACTIVITY DATA

MATERIALS	SAND				GRAVEL			
CEMENT NO.		Petro Only						
SODA EQUIVALENT								
TEST AGG %	100	100	50	25	100	100	50	25
EXP % — 6 MO								
EXP % — 12 MO								

PETROGRAPHIC DESCRIPTION: MEMORANDUM NO. 50-161 DATE: 10-25-50 BY: R. H. Cook

The oversize material (No. 4 - 3/8 inch) in the sand is composed predominantly of granites, granite gneisses, feldspars and quartz. The sand, subengular to angular in shape, is composed predominantly of granite and granite gneisses with smaller proportions of feldspar, quartz, and schist. Many of the feldspar particles (20 to 25 percent of the sand) have been partially altered to sericite and clay. About 5 to 10 percent of the sand is physically unsound and no deleteriously reactive material was found in the sample.

Conclusions: Sand comparable to Sample No. M-893 is suitable for use in concrete provided proper gradings are obtained.

BIA report no.: BR 11

EL-251
(2-62)

ASSISTANT COMMISSIONER AND CHIEF ENGINEER
DIVISION OF ENGINEERING LABORATORIES
CONCRETE AND STRUCTURAL BRANCH

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION

STATE Wyoming	SOURCE NO. 2	AGGREGATE ~~RIPRAP~~	REPORT NO. C- 567A DATE 2-28-1952
LAT. 42° N	LONG. 109° W		LAB. SAMPLE NO. M- 1095 REG. 6
TYPE OF MATERIAL Coarse Aggregate			DATE REC'D. 8-20-1951
LTR. TRANSMITTAL District Manager			DATE 8-24-1951
NAME OF DEPOSIT Raft Lake			
LOCATION Northeast shore of Raft Lake			
SEC. 8	T 1 S	R 4 W	MERIDIAN Wind River
OWNERSHIP Not Furnished			
VOLUME 30,000 cubic yards		OVERBURDEN	Not Furnished
FEATURE Raft Lake Dam			
PROJECT Missouri River Basin			COMPILED BY JDR
REMARKS *Freeze-thaw mix used M-1095 gravel			CHECKED BY RNH
and local Clear Creek sand.			REVIEWED BY
			SUBMITTED BY

GRADING (DES. 4,5,6) (CUM. % RETAINED)

SIEVE	PIT RUN	3"-1½"	1½"-¾"	¾"-#4	FINE AGG.
6 IN.	0				
3½ IN.	--				
3 IN.	0				
2½ IN.	--				
1¾ IN.	--				
1½ IN.	5				
1¼ IN.	--				
⅞ IN.	--				
¾ IN.	45				
⅝ IN.	--				
⅜ IN.	76				
5/16 IN.	--				
NO. 4	100				
NO. 5					
NO. 8					
NO. 16					
NO. 30					
NO. 50					
NO. 100					
PAN					
F. M.	7.26				
% SAND	17				

TEST RESULTS

	6"-3"	3-1½	1½-¾	¾-⅜	⅜-#4	FINE AGG.	WASHED FINE AGG.
SP. GR., S.S.D. (DES. 9, 10)		2.74	2.73	2.72	2.71		
ABSORPTION, PERCENT (DES. 9, 10)		0.4	0.6	0.7	0.6		
ORGANIC IMPURITIES, COLOR (DES. 14)	—	—	—	—	—		
PERCENT SILT (DES. 16)							
PERCENT LIGHTER THAN SP GR.							
CLAY LUMP, % (DES. 13)							
SAND EQUIVALENT	—	—	—	—	—		
NA_2SO_4 LOSS, 5 CYC WGTD % LOSS (DES. 19)	—	—	6.6			—	

L.A. ABRASION (DES 21) GRADING	"A"	"B"	"C"	"D"	
% LOSS, 100 REV.	5.4				—
% LOSS 500 REV.	25.3				—

FREEZING AND THAWING DATA

CONCRETE* W/C RATIO	SLUMP INCHES	% AIR METER	H_2O LBS/YD³	28-DAY STR. 3"x6" CYL.	WGT. LOSS %	CYCLES	RIPRAP WGT. LOSS % 3 INCH CUBE	CYCLES
0.51	3.0	4.9	286	4,620	25	720		

ALKALI — AGGREGATE REACTIVITY DATA

MATERIALS	SAND				GRAVEL			
CEMENT NO.		Petro Only				Petro Only		
SODA EQUIVALENT								
TEST AGG %	100	100	50	25	100	100	50	25
EXP % — 6 MO								
EXP % — 12 MO								

PETROGRAPHIC DESCRIPTION: MEMORANDUM NO. 51-127 DATE: 9-13-1951 BY: R. H. Cook

The gravel particles range from anguler to subrounded in shape. The gravel is composed of 95.4 percent granites and granite gneisses and approximately 4.6 percent quartzite. Physically unsound particles constitute only an average of 0.3 percent of the sample examined. There were no materials found in the sample which would react deleteriously with high-alkali cement.

Conclusions: Gravel comparable to Sample No. M-1095 is suitable for use in concrete provided proper gradings are obtained.

BIA report no.: BR 12

EL-251
(2-62)

ASSISTANT COMMISSIONER AND CHIEF ENGINEER
DIVISION OF ENGINEERING LABORATORIES
CONCRETE AND STRUCTURAL BRANCH

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION

AGGREGATE ~~RIPRAP~~

STATE	Wyoming	SOURCE NO.	24
LAT.	43° N	LONG.	108° W
REPORT NO. C-	367A	DATE	6-21-50
LAB. SAMPLE NO.	*	REG.	6
TYPE OF MATERIAL	Sand and gravel	DATE REC'D.	9-5-47
LTR. TRANSMITTAL	Construction Engineer	DATE	9-2-47
NAME OF DEPOSIT	Kinnear Bridge		
LOCATION	South side of Wind River in		
SEC.	24	T 2 N, R 1 E	MERIDIAN Wind River
OWNERSHIP	Indian land		
VOLUME	In excess of 10,000 cu yd	OVERBURDEN	1/2 to 2 feet
FEATURE	Wyoming Canal		
PROJECT	Riverton	COMPILED BY	JDR
REMARKS	*Samples No. 8259, 8260, and 8261.	CHECKED BY	RNH
	Results shown are an average.	REVIEWED BY	
		SUBMITTED BY	

GRADING (DES. 4,5,6) (CUM % RETAINED)

SIEVE	PIT RUN	3"-1½"	1½"-¾" Pit run	¾"-#4	FINE AGG. Washed
6 IN.	0				
3½ IN.	--				
3 IN.	0				
2½ IN.	--				
1¾ IN.	--				
1½ IN.	0				
1¼ IN.	--				
⅞ IN.	--				
¾ IN.	46				
⅝ IN.	--				
⅜ IN.	81				
5/16 IN.	--				
NO 4	100		-0		0
NO. 5			--		--
NO. 8			14		17
NO. 16			24		31
NO. 30			42		51
NO 50			75		81
NO. 100			91		96
PAN			100		100
F. M.	7.27		2.46		2.76
% SAND	39				

TEST RESULTS

	6"-3"	3-1½	1½-¾	¾-⅜	⅜-#4	FINE AGG.	WASHED FINE AGG
SP. GR., S.S.D. (DES. 9, 10)	--	--	2.64	2.62	2.61	2.63	2.64
ABSORPTION, PERCENT (DES. 9, 10)	--	--	0.8	1.2	1.3	0.8	0.7
ORGANIC IMPURITIES, COLOR (DES. 14)	—	—	—	—	—	No. 1	
PERCENT SILT (DES. 16)						4.4	
PERCENT LIGHTER THAN SP GR.							
CLAY LUMP, % (DES. 13)							
SAND EQUIVALENT	—	—	—	—	—		
Na_2SO_4 LOSS, 5 CYC WGTD % LOSS (DES. 19)	—	—	3.3			—	2.7

L.A. ABRASION (DES 21) GRADING	"A"	"B"	"C"	"D"	
% LOSS, 100 REV.	4.1				—
% LOSS 500 REV.	18.9				—

FREEZING AND THAWING DATA

CONCRETE							RIPRAP	
W/C RATIO	SLUMP INCHES	% AIR METER	H_2O LBS/YD³	28-DAY STR. 3"x6" CYL	WGT. LOSS %	CYCLES	WGT. LOSS % 3 INCH CUBE	CYCLES
	Not tested							

ALKALI — AGGREGATE REACTIVITY DATA

MATERIALS	SAND				GRAVEL			
CEMENT NO.		Petro only				Petro only		
SODA EQUIVALENT								
TEST AGG %	100	100	50	25	100	100	50	25
EXP % — 6 MO								
EXP % — 12 MO								

PETROGRAPHIC DESCRIPTION: MEMORANDUM NO. 50-68 DATE: 5-1-50 BY: T. R. Magorian

The gravel particles average subround in shape and are composed mainly of basalts, quartzites, granites, and diorites with lesser amounts of sandstones, siltstones, shales, limestones, cherts, rhyolites, and andesites. Physically unsound particles constitute 1 percent, and materials deleteriously reactive with high-alkali cement constitute an average of 18 percent. The sand particles average subangular in shape and are similar lithologically to the gravels. Physically unsound particles constitute about 10 percent. Materials deleteriously reactive with high-alkali cement constitute about 20 percent of the sand sample analyzed.

Conclusions: Aggregate comparable to Samples No. 8259, 8260, and 8261 is suitable for use in concrete provided the sand is washed to remove excess silt, proper gradings are obtained, and low-alkali cement is used.

BIA report no.: BR 13

EL-251
(2-62)

ASSISTANT COMMISSIONER AND CHIEF ENGINEER
DIVISION OF ENGINEERING LABORATORIES
CONCRETE AND STRUCTURAL BRANCH

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION

AGGREGATE ~~XXXXXXX~~

STATE Wyoming	SOURCE NO. 5	REPORT NO. C- 266	DATE 1-15-45
LAT. 43° N	LONG. 108° W	LAB. SAMPLE NO 5683	REG. 6
TYPE OF MATERIAL Sand and gravel		DATE REC'D. 11-11-44	
LTR. TRANSMITTAL Project Superintendent			DATE 10-25-44
NAME OF DEPOSIT Pilot Butte			
LOCATION about	SEC. 34	T 3 N	R 1 E
MERIDIAN Wind River			
OWNERSHIP Not furnished			
VOLUME Not furnished	OVERBURDEN Not furnished		
FEATURE Pilot Butte Wasteway			
PROJECT Riverton		COMPILED BY JDR	
REMARKS 1/ Information not available		CHECKED BY RNH	
		REVIEWED BY	
		SUBMITTED BY	

GRADING (DES. 4,5,6) (CUM. % RETAINED)

SIEVE	PIT RUN	3"-1½"	1½"-¾"	¾"-#4	FINE AGG.
6 IN.	0				
3½ IN	--				
3 IN.	0				
2½ IN.	--				
1¾ IN.	--				
1½ IN.	13				
1¼ IN.	--				
7/8 IN.	--				
3/4 IN.	50				
5/8 IN.	--				
3/8 IN.	75				
5/16 IN.	--				
NO.4	100				0
NO.5					--
NO 8					18
NO.16					24
NO.30					45
NO.50					71
NO.100					93
PAN					100
F.M.	7.38				2.46
% SAND	45				

TEST RESULTS

	6"-3"	3-1½	1½-¾	¾-3/8	3/8-#4	FINE AGG.	WASHED FINE AGG.
SP. GR., S.S.D. (DES. 9, 10)	--	2.64	2.63	2.62	2.62	2.64	1/
ABSORPTION, PERCENT (DES. 9, 10)	--	1.0	1.2	1.3	1.4	0.3	1/
ORGANIC IMPURITIES, COLOR (DES. 14)	—	—	—	—	—	Clear	—
PERCENT SILT (DES. 16)						4.1	
PERCENT LIGHTER THAN SP GR.							
CLAY LUMP, % (DES. 13)							
SAND EQUIVALENT	—	—	—	—	—		
NA_2SO_4 LOSS, 5 CYC WGTD % LOSS (DES. 19)	—	—	1.2			—	3.4

L.A. ABRASION (DES 21) GRADING	"A"	"B"	"C"	"D"	
% LOSS, 100 REV.	--				—
% LOSS 500 REV.	21.6				—

FREEZING AND THAWING DATA

CONCRETE							RIPRAP	
W/C RATIO	SLUMP INCHES	% AIR METER	H_2O LBS/YD^3	28-DAY STR. 3"x6" CYL	WGT. LOSS %	CYCLES	WGT. LOSS % 3 INCH CUBE	CYCLES
	Not tested							

ALKALI — AGGREGATE REACTIVITY DATA

MATERIALS	SAND				GRAVEL			
CEMENT NO.		Petro only				Petro only		
SODA EQUIVALENT								
TEST AGG %	100	100	50	25	100	100	50	25
EXP % — 6 MO								
EXP % — 12 MO								

PETROGRAPHIC DESCRIPTION: ~~XXXXXXX~~ Report NO. C-266 DATE: 1-15-45 BY: R. C. Mielenz

The gravels are composed predominantly of volcanic rocks, gneisses, and schists and are rounded in shape. About 1.8 percent are physically unsound.

The sand is angular to subangular in shape and is composed of the same rock types observed in the gravel. Physically unsound particles constitute about 5 to 10 percent of the sand.

Conclusions: Aggregate comparable to Sample No. 5683 is suitable for use in concrete provided the sand is washed to remove excess silt, proper gradings are obtained, and low-alkali cement is used.

BIA report no.: BR 14

EL-651 (4-71)
Bureau of Reclamation

CONCRETE AND STRUCTURAL BRANCH
DIVISION OF GENERAL RESEARCH
ENGINEERING AND RESEARCH CENTER
DENVER, COLORADO 80225
DATE June 1975

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION

AGGREGATE
XXXXXXX
QUALITY EVALUATION

BRANCH FILE NO. C- 1387
COMPILED BY
CHECKED BY
REVIEWED BY
SUBMITTED BY

STATE Wyoming	REG. UM	SOURCE NO. 36	LAT. 43° N / LONG. 108° W
SAMPLE NO. M- 6557*	MATERIAL Sand and gravel		DATE REC'D. 6-21-74
DEPOSIT NAME Argo Butte Area			OVERBURDEN 1 to 2 feet
OWNERSHIP Bureau of Reclamation			VOLUME 2,400,000 cu yds
LOCATION S 1/2	SEC. 16	T 3 N / R 1 W	MERIDIAN Wind River
FEATURE Wind River Diversion Dam			
PROJECT Pick-Sloan Missouri Basin Program			
REMARKS * Field identification: sample No. 1, test pit No. 1, 3' to 8' depth			
			DATE LTR. TRANS. 6-14-74

GRADING (DES. 4, 5, 6) CUM. % RETAINED

SIEVE	PIT RUN	3"-1 1/2"	1 1/2"-3/4"	3/4"-#4	FINE AGG.	WASHED FINE AGG.
6 IN.	2					
3 1/2 IN.	–					
3 IN.	22					
2 1/2 IN.	–					
1 3/4 IN.	–					
1 1/2 IN.	48					
1 1/4 IN.	–					
7/8 IN.	–					
3/4 IN.	72					
5/8 IN.	–					
3/8 IN.	90					
5/16 IN.	–					
NO. 4	100				0	0
NO. 5					–	–
NO. 8					29	30
NO. 16					48	49
NO. 30					64	66
NO. 50					82	84
NO. 100					93	95
PAN					100	100
F.M.	8.34	—	—	—	3.16	3.24
% SAND	20	—	—	—	—	—

TEST RESULTS

	6"-3"	3"-1 1/2"	1 1/2"-3/4"	3/4"-3/8"	3/8"-#4	FINE AGG.	WASHED FINE AGG.
SP. GR., S.S.D. (DES. 9, 10)		2.64	2.67	2.64	2.63		2.63
ABSORPTION, % (DES. 9, 10)		0.6	1.1	1.4	1.6		1.6
ORGANIC IMPURITIES, (DES. 14)	—	—	—	—	—	clear	
PERCENT SILT (DES. 16)						3.4	
% LIGHTER - SP. GR. (DES. 17, 18, 42)							
CLAY LUMPS, % (DES. 13)							
SAND EQUIVALENT	—	—	—	—	—		
NA_2SO_4 LOSS, 5 CYC. WGTD. % LOSS (DES. 19)				4.5		—	5.9

L.A. ABRASION (DES. 21)	GRADING "A"	"B"	"C"	"D"
% LOSS, 100 REV.	6.5			
% LOSS, 500 REV.	25.5			

FREEZING AND THAWING DATA

CONCRETE							RIPRAP	
W/C RATIO	SLUMP INCHES	% AIR METER	H_2O LBS/YD³	28-DAY STRENGTH 3"x6" CYLS.	WEIGHT LOSS, %	CYCLES	WEIGHT LOSS, % 3 INCH CUBE	CYCLES
0.51	3.1	5.0	285	3,560	25	385		

ALKALI-AGGREGATE REACTIVITY DATA

MATERIALS	SAND				GRAVEL			
CEMENT NO.		Not tested				Not tested		
SODA EQUIVALENT								
TEST AGG. %	100	100	50	25	100	100	50	25
EXP % - 6 MO.								
EXP % - 12 MO.								

PETROGRAPHIC DESCRIPTION: MEMORANDUM NO. 74-24 DATE: 9-30-74 BY: C. A. Bechtold

The gravel, subround with about 25 percent subangular, about 10 percent flattened, and about 27 percent calcium carbonate and sand grain encrusted particles, consists essentially of granite and gneiss, glassy volcanics and limestone with lesser amounts of sandstone and quartzite, basalt, and chert. About 3 percent physically unsound and about 28 percent alkali-reactive rock types are present. The sand, subround to angular in shape, is composed of the same rock types found in the gravel and some broken calcium carbonate coating fragments in addition to increasing amounts of monomineralic grains of quartz, feldspar, amphibole, mica, epidote, magnetite, calcite, and a few miscellaneous minerals in the finer sizes. About 8 percent of the sand is physically unsound and 11 percent alkali-reactive material was observed.

Conclusions: Aggregate comparable to sample No. M-6557 is suitable for use in concrete provided the sand is washed to remove excess silt, proper gradings are obtained, and low alkali cement is used. Freeze-thaw tests indicate that to produce concrete of the desired durability it may be necessary to reduce the water-cement ratio to 0.45.

BIA report no.: BR 15

EL-251
(2-62)

ASSISTANT COMMISSIONER AND CHIEF ENGINEER
DIVISION OF ENGINEERING LABORATORIES
CONCRETE AND STRUCTURAL BRANCH

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION

STATE Wyoming	SOURCE NO. 1	AGGREGATE ~~RIPRAP~~	REPORT NO. C- * Memo	DATE 10-30-35	
LAT. 43° N	LONG. 108° W		LAB. SAMPLE NO. None		REG. 6
TYPE OF MATERIAL	Sand and gravel		DATE REC'D. 10-17-35		
LTR. TRANSMITTAL	Superintendent, Riverton, Wyoming			DATE 10-11-35	
NAME OF DEPOSIT	Cut Bank				
LOCATION					
SE 1/4	SEC. 16	T 3 N	R 2 W	MERIDIAN Wind River	
OWNERSHIP	Not furnished				
VOLUME	Not furnished		OVERBURDEN 5 to 7 feet		
FEATURE	Bull Lake Dam				
PROJECT	Riverton		COMPILED BY	JDR	
REMARKS	*Memorandum to E. N. Vidal		CHECKED BY	RNH	
			REVIEWED BY		
			SUBMITTED BY		

GRADING (DES. 4,5,6) (CUM. % RETAINED)

SIEVE	PIT RUN	3"-1½"	1½"-¾"	¾"-#4	FINE AGG.
6 IN.	0				
3 ½ IN.	--				
3 IN.	0				
2 ½ IN.	--				
1 ¾ IN.	--				
1 ½ IN.	10				
1 ¼ IN.	--				
⅞ IN.	--				
¾ IN.	44				
⅝ IN.	--				
⅜ IN.	79				
5/16 IN.					
NO. 4	100				0
NO. 5					--
NO. 8					14
NO. 16					24
NO. 30					48
NO. 50					80
NO. 100					94
PAN					100
F. M.	7.33				260
% SAND	45				

TEST RESULTS

	6"-3"	3-XXXXXXXXXX				FINE AGG.	WASHED FINE AGG.
SP. GR., S.S.D. (DES. 9, 10)	--			2.63		2.61	1/
ABSORPTION, PERCENT (DES. 9, 10)				0.4			1/
ORGANIC IMPURITIES, COLOR (DES. 14)	—	—	—	—	—	No.	
PERCENT SILT (DES. 16)						3.6	
PERCENT LIGHTER THAN SP GR.							
CLAY LUMP, % (DES. 13)							
SAND EQUIVALENT	—	—	—	—	—		
NA_2SO_4 LOSS, 5 CYC WGTD % LOSS (DES. 19)	—	—		1/		—	1/
L.A. ABRASION (DES 21) GRADING	"A"	"B"		"C"	"D"		—
% LOSS, 100 REV.	Not tested						—
% LOSS 500 REV.							—

FREEZING AND THAWING DATA

CONCRETE							RIPRAP	
W/C RATIO	SLUMP INCHES	% AIR METER	H_2O LBS/YD³	28-DAY STR. 3"x6" CYL.	WGT. LOSS %	CYCLES	WGT. LOSS % 3 INCH CUBE	CYCLES
		Not tested						

ALKALI — AGGREGATE REACTIVITY DATA

MATERIALS	SAND				GRAVEL			
CEMENT NO.		Petro only				Petro only		
SODA EQUIVALENT								
TEST AGG %	100	100	50	25	100	100	50	25
EXP % — 6 MO								
EXP % — 12 MO								

PETROGRAPHIC DESCRIPTION: MEMORANDUM NO. 1/ DATE: 1/ BY: 1/.

The gravel consists of granite and basalt with some vesicular basalt in limited amounts. The sand is primarily quartz and feldspar, granite, sandstone, and other feldspathic rocks, limestone, schist, and small amounts of mica, magnetite, and chert. About 30 percent of the aggregate had a thin, white layer of calcium adhering to about one forth of the surface.

Conclusions: If this source is considered for future Bureau use, suitability tests should be made in the Denver laboratory to determine the quality of material currently available.

1/ Information not available.

BIA report no.: BR 16

EL-251
(2-62)

ASSISTANT COMMISSIONER AND CHIEF ENGINEER
DIVISION OF ENGINEERING LABORATORIES
CONCRETE AND STRUCTURAL BRANCH

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION

AGGREGATE ~~RIPRAP~~

STATE	Wyoming	SOURCE NO.	1
LAT.	43° N	LONG.	109° W
REPORT NO.	Memo*	DATE	10-30-35
LAB. SAMPLE NO.	None	REG.	6
TYPE OF MATERIAL	Sand and gravel	DATE REC'D.	10-17-35
LTR. TRANSMITTAL	Superintendent, Riverton, Wyoming	DATE	10-11-35
NAME OF DEPOSIT	Wind River		
LOCATION	On south side of Wind River		
SEC.	S 1/2 8	T / R	3 N / 2 W
MERIDIAN	Wind River		
OWNERSHIP	Indian Trusts		
VOLUME	10 acres--5 to 12 feet deep	OVERBURDEN	0 to 7 feet
FEATURE	Bull Lake Dam		
PROJECT	Riverton	COMPILED BY	RNH
REMARKS	*Memorandum to E. N. Vidal. Test results shown are an average of five gravel pits. 1/ Information not available.	CHECKED BY	JDR
		REVIEWED BY	
		SUBMITTED BY	

GRADING (DES. 4,5,6) (CUM. % RETAINED)

SIEVE	PIT RUN	3"-1½"	1½"-¾"	¾"-No.4	FINE AGG.
6 IN.	0				
3½ IN.	--				
3 IN.	0				
2½ IN.	--				
1¾ IN.	--				
1½ IN.	21				
1¼ IN.	--				
7/8 IN.	--				
¾ IN.	62				
5/8 IN.	--				
3/8 IN.	89				
5/16 IN.	--				
NO. 4	100				0
NO. 5					--
NO. 8					12
NO. 16					24
NO. 30					48
NO. 50					74
NO. 100					91
PAN					100
F.M.	7.72				249
% SAND	35				

TEST RESULTS

	6"-3"	3" [illegible]				FINE AGG.	WASHED FINE AGG.
SP. GR., S.S.D. (DES. 9, 10)	--			2.57		2.62	
ABSORPTION, PERCENT (DES. 9, 10)	—			0.7		0.6	
ORGANIC IMPURITIES, COLOR (DES. 14)	—	—	—	—	—	No. 1	
PERCENT SILT (DES. 16)						2.5	
PERCENT LIGHTER THAN SP GR.							
CLAY LUMP, % (DES. 13)							
SAND EQUIVALENT	—	—	—	—	—		
Na_2SO_4 LOSS, 5 CYC WGTD % LOSS (DES. 19)	—	—	1/			—	4.7

L.A. ABRASION (DES 21) GRADING	"A"	"B"	"C"	"D"	
% LOSS, 100 REV.	1/				—
% LOSS 500 REV.					—

FREEZING AND THAWING DATA

CONCRETE							RIPRAP	
W/C RATIO	SLUMP INCHES	% AIR METER	H_2O LBS/YD^3	28-DAY STR. 3"x6" CYL.	WGT. LOSS %	CYCLES	WGT. LOSS % 3 INCH CUBE	CYCLES
		Not	tested					

ALKALI — AGGREGATE REACTIVITY DATA

MATERIALS	SAND				GRAVEL			
CEMENT NO.		Petro only				Petro only		
SODA EQUIVALENT								
TEST AGG %	100	100	50	25	100	100	50	25
EXP % — 6 MO								
EXP % — 12 MO								

PETROGRAPHIC DESCRIPTION: MEMORANDUM NO. 1/ DATE: 1/ BY: 1/

The gravéls consist of granite and basalt with some vesicular basalt in limited amounts. The sands consist primarily of quartz and feldspar, granite, sandstone and other feldspathic rocks, limestone schist, and small amounts of mica, magnetite and chert. There is a slight amount of calcareous coatings on the coarse sand grains.

Conclusions: If this source is considered for future Bureau use, suitability tests should be made in the Denver laboratory to determine the quality of material currently available.

BIA report no.: BR 17

EL-251
(2-62)

ASSISTANT COMMISSIONER AND CHIEF ENGINEER
DIVISION OF ENGINEERING LABORATORIES
CONCRETE AND STRUCTURAL BRANCH

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION

STATE Wyoming	SOURCE NO. 32	AGGREGATE	REPORT NO. C- * DATE --
LAT. 43° N	LONG. 108° W	~~RIPRAP~~	LAB. SAMPLE NO. M- 3709* REG. 6
TYPE OF MATERIAL	Sand and gravel		DATE REC'D. 12-2-57
LTR. TRANSMITTAL	Construction Engineer		DATE 11-27-57
NAME OF DEPOSIT	Owl Creek Bench		
LOCATION	Right side of Owl Creek, 5,000 feet upstream from dam		
about	SEC. 14 T 8 N R 1 W		MERIDIAN Wind River
OWNERSHIP	U.S. Government		
VOLUME	Not furnished	OVERBURDEN	Not furnished
FEATURE *	Anchor Dam--Owl Creek Unit		
PROJECT	Missouri River Basin		COMPILED BY RNH
REMARKS	*This source previously tested.		CHECKED BY HED
	Samples No. 6943, 6944, M-552, M-2990		REVIEWED BY
	Report No. C-295A, C-498		SUBMITTED BY

GRADING (DES. 4,5,6) (CUM. % RETAINED)

SIEVE	PIT RUN	3"-1½"	1½"-¾"	¾"-#4	Washed FINE AGG.
6 IN.			1/		
3½ IN.		0			
3 IN.		0			
2½ IN.		27			
1¾ IN.		--	0		
1½ IN.		87	0		
1¼ IN.		98	36		
7/8 IN.			--	0	
¾ IN.			96	1	
5/8 IN.			99	--	
3/8 IN.				50	
5/16 IN.				--	
NO. 4	2			93	2
NO. 5	--			97	--
NO. 8	14				14
NO. 16	36				37
NO. 30	64				63
NO. 50	89				87
NO. 100	97				97
PAN	100				100
F.M.	3.03				300
% SAND					

TEST RESULTS

	6"-3"	3-1½	1½-¾	¾-3/8	3/8-#4	FINE AGG.	WASHED FINE AGG.
SP. GR., S.S.D. (DES. 9, 10)	2.57	2.60	2.55	2.58	2.57	2.59	2.59
ABSORPTION, PERCENT (DES. 9, 10)	1.1	1.3	2.2	2.2	2.4	2.3	2.2
ORGANIC IMPURITIES, COLOR (DES. 14)	—	—	—	—	—	Clear	
PERCENT SILT (DES. 16)						4.1	
PERCENT LIGHTER THAN SP GR.							
CLAY LUMP, % (DES. 13)							
SAND EQUIVALENT	—	—	—	—	—		
NA_2SO_4 LOSS, 5 CYC WGTD % LOSS (DES. 19)	—	—	8.7			—	8.7

L.A. ABRASION (DES 21) GRADING	"A"	"B"	"C"	"D"	
% LOSS, 100 REV.	4.7				—
% LOSS 500 REV.	26.3				—

FREEZING AND THAWING DATA 2/

CONCRETE W/C RATIO	SLUMP INCHES	% AIR METER	H_2O LBS/YD³	28-DAY STR. 3"x6" CYL	WGT. LOSS %	CYCLES	RIPRAP WGT. LOSS % 3 INCH CUBE	CYCLES
0.51	3.7	4.3	281	3,650	25	800		

ALKALI — AGGREGATE REACTIVITY DATA 2/

MATERIALS	SAND				GRAVEL			
CEMENT NO.	2735	3562			2735	3562		
SODA EQUIVALENT	0.13	1.23			0.13	1.23		
TEST AGG %	100	100	50	25	100	100	50	25
EXP % — 6 MO	-.004	.030	.303	.287	-.003	.075	.323	.332
EXP % — 12 MO	.011	.109	.441	.447	.012	.202	.422	.438

PETROGRAPHIC DESCRIPTION: MEMORANDUM NO. 57-134 DATE: 12-2-57 BY: C. A. Bechtold

1/The gravel, subrounded to subangular in shape, is composed mainly of limestone, dolomite, and glassy or devitrified fine-grained igneous rocks ranging from acid to intermediate in composition. About 3 percent of the gravel is physically unsound and 45 percent is deleteriously reactive. The sand, subangular to angular in shape, is composed of the same rock types found in the gravel with increasing amounts of individual grains of quartz, feldspar, amphiboles, mica, iron oxides, and magnetite in the finer sizes. About 5 percent of the sand is physically unsound and 20 percent is deleteriously reactive.

Conclusions: Although not of first quality, aggregate comparable to Sample No. M-3709 is suitable for use in concrete provided the sand is washed to remove excess silt, proper gradings are obtained and low-alkali cement is used.

1/Gravel grading and petrographic examination are for Sample No. M-2990.
2/These results are for Sample No. M-552. All other results are for Sample No. M-3079.

EL-251
(2-62)

ASSISTANT COMMISSIONER AND CHIEF ENGINEER
DIVISION OF ENGINEERING LABORATORIES
CONCRETE AND STRUCTURAL BRANCH

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION

AGGREGATE ~~XXXXXX~~

STATE Wyoming	SOURCE NO. 20	REPORT NO. C-367A		DATE 6-21-50	
LAT. 43° N	LONG. 108° W	LAB SAMPLE NO. --			REG. 6
TYPE OF MATERIAL	Sand and gravel	DATE REC'D. 7-27-47			
LTR. TRANSMITTAL	Construction Engineer			DATE 7-17-47	
NAME OF DEPOSIT	Five-mile Creek				
LOCATION	S 1/2 Section 15 and the N 1/2	SEC. 22	T 4 N	R 1 E	MERIDIAN Wind River
OWNERSHIP	Indian land				
VOLUME	At least 7,500 cubic yds	OVERBURDEN	Not furnished		
FEATURE	Wyoming Canal				
PROJECT	Riverton	COMPILED BY JDR			
REMARKS	*Samples No. 8143, 8144, 8145, and 8146. Test results shown are for Sample No. 8146.	CHECKED BY RNH			
		REVIEWED BY			
		SUBMITTED BY			

GRADING (DES 4,5,6) (CUM. % RETAINED)

SIEVE	PIT RUN	3"-1½"	1½"-¾" Pit run	¾"-#4	FINE AGG. Washed
6 IN.	0				
3½ IN.	--				
3 IN.	0				
2½ IN.	--				
1¾ IN.	--				
1½ IN.	0				
1¼ IN.	--				
⅞ IN.	--				
¾ IN.	38				
⅝ IN.	--				
⅜ IN.	69				
5/16 IN.	--				
NO. 4	100		0		0
NO. 5			--		--
NO. 8			19		21
NO. 16			54		54
NO. 30			74		74
NO. 50			84		84
NO. 100			95		96
PAN			100		100
F. M.	7.07		3.26		3.29
% SAND	66				

TEST RESULTS

	6"-3"	3-1½	1½-¾	¾-⅜	⅜-#4	FINE AGG.	WASHED FINE AGG.
SP. GR., S.S.D. (DES. 9, 10)	--	--	2.61	2.61	2.57	2.47	2.56
ABSORPTION, PERCENT (DES. 9, 10)	--	--	0.5	0.6	1.1	3.5	2.1
ORGANIC IMPURITIES, COLOR (DES. 14)	—	—	—	—	—	No. 1	
PERCENT SILT (DES. 16)						7.1	
PERCENT LIGHTER THAN SP GR.							
CLAY LUMP, % (DES. 13)							
SAND EQUIVALENT	—	—	—	—	—		
Na_2SO_4 LOSS, 5 CYC WGTD % LOSS (DES. 19)	—	—	3.6			—	4.6

L.A. ABRASION (DES 21) GRADING	"A"	"B"	"C"	"D"	
% LOSS, 100 REV.	5.8				—
% LOSS 500 REV.	24.0				—

FREEZING AND THAWING DATA

CONCRETE							RIPRAP	
W/C RATIO	SLUMP INCHES	% AIR METER	H_2O LBS/YD³	28-DAY STR. 3"x6" CYL	WGT. LOSS %	CYCLES	WGT. LOSS % 3 INCH CUBE	CYCLES
	Not tested							

ALKALI — AGGREGATE REACTIVITY DATA

MATERIALS	SAND				GRAVEL			
CEMENT NO.		Petro only				Petro only		
SODA EQUIVALENT								
TEST AGG %	100	100	50	25	100	100	50	25
EXP % — 6 MO								
EXP % — 12 MO								

PETROGRAPHIC DESCRIPTION: MEMORANDUM NO. -- DATE: 4-19-47 BY: M. E. King

The gravels are composed of hard quartzites and granites with smaller proportions of cherts, weathered granites, and calcareous siltstones. The pebbles range in shape from round to subround and most are partially coated with firmly bonded calcium caliche. Also, most of the pebbles are stained with iron oxide of which a large porportion can be removed by vigorous washing. The sands are lithologically similar to the gravels. The sands are coated with a red stain of iron oxide which can be removed by washing. Physically unsound particles average 3.2 percent of the gravels and about 15 percent of the sand. Chemically deleterious materials average 4.5 percent of the gravels and about 5 percent of the sand.

Conclusions: Although the sand has a low specific gravity, aggregate comparable to Samples No. 8143 through 8146 is suitable for use in concrete provided the sand is washed to remove excess silt, proper gradings are obtained, and low-alkali cement is used.

BIA report no.: BR 19

EL-251
(2-62)

ASSISTANT COMMISSIONER AND CHIEF ENGINEER
DIVISION OF ENGINEERING LABORATORIES
CONCRETE AND STRUCTURAL BRANCH

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION

STATE	Wyoming	SOURCE NO.	19	AGGREGATE	REPORT NO. C- 367 / DATE 9-16-47
LAT.	43° N	LONG.	108° W	~~RIPRAP~~	LAB. SAMPLE NO 7391 / REG. 6
TYPE OF MATERIAL	Sand and gravel				DATE REC'D. 11-19-46
LTR. TRANSMITTAL	Acting Project Engineer				DATE 11-13-46
NAME OF DEPOSIT	Antelope Pit				
LOCATION	SEC. 9, 16	T 4 N	R 3 E	MERIDIAN	Wind River
OWNERSHIP	U.S. Government				
VOLUME	Not furnished		OVERBURDEN	Not furnished	
FEATURE	Lost Wells Laterals and Wyoming Canal				
PROJECT	Missouri River Basin			COMPILED BY	JDR
REMARKS				CHECKED BY	RNH
				REVIEWED BY	
				SUBMITTED BY	

GRADING (DES. 4,5,6) (CUM. % RETAINED)

SIEVE	PIT RUN	3"-1½"	~~1½"-¾"~~ Pit run	¾"-#4	Washed FINE AGG.
6 IN.	0				
3½ IN.	--				
3 IN.	0				
2½ IN.	--				
1¾ IN.	--				
1½ IN.	8				
1¼ IN.	--				
7/8 IN.	--				
3/4 IN.	37				
5/8 IN.	--				
3/8 IN.	71				
5/16 IN.	--				
NO. 4	100		0		0
NO. 8			--		--
NO. 8			32		40
NO. 16			46		56
NO. 30			53		64
NO. 50			62		74
NO. 100			78		89
PAN			100		100
F. M.	7.16		2.71		3.23
% SAND	30				

TEST RESULTS

	6"-3"	3-1½	1½-¾	¾-3/8	3/8-#4	FINE AGG.	WASHED FINE AGG.
SP. GR., S.S.D. (DES. 9, 10)	--	2.66	2.58	2.58	2.56	2.58	2.63
ABSORPTION, PERCENT (DES. 9, 10)	--	0.8	1.7	1.7	2.0	2.4	1.2
ORGANIC IMPURITIES, COLOR (DES. 14)	—	—	—	—	—	No. 1	--
PERCENT SILT (DES. 16)						22.0	--
PERCENT LIGHTER THAN SP GR.							
CLAY LUMP, % (DES. 13)							
SAND EQUIVALENT	—	—	—	—	—		
Na_2SO_4 LOSS, 5 CYC WGTD % LOSS (DES. 19)	—	—	5.1			—	9.4

L.A. ABRASION (DES 21) GRADING	"A"	"B"	"C"	"D"	
% LOSS, 100 REV.	7.9				—
% LOSS 500 REV.	30.0				—

FREEZING AND THAWING DATA

CONCRETE: W/C RATIO	SLUMP INCHES	% AIR METER	H_2O LBS/YD³	28-DAY STR. 3"x6" CYL.	WGT. LOSS %	CYCLES	RIPRAP: WGT. LOSS % 3 INCH CUBE	CYCLES
	Not tested							

ALKALI - AGGREGATE REACTIVITY DATA

MATERIALS	SAND				GRAVEL			
CEMENT NO.		Petro only				Petro only		
SODA EQUIVALENT								
TEST AGG %	100	100	50	25	100	100	50	25
EXP % - 6 MO								
EXP % - 12 MO								

PETROGRAPHIC DESCRIPTION: ~~XXXXXXXXXX~~ Report NO. C-367 DATE: 9-16-47 . BY: L. C. Zima

The gravel is subangular in shape and is composed mainly of limestones, cherts, and sandstones, with small amounts of basalt, granite, and granite gneisses. Unsound material constitutes 9 percent and deleteriously reactive particles constitute 21.9 percent of the gravel.

The sand is subangular in shape and is composed mainly of cherts, chalcedony, limestones, and sandstones. Unsound material constitutes 15 to 20 percent of the sand.

Conclusions: Although the sand is marginal in the sulfate soundness test and the gravel has a low specific gravity, aggregate comparable to Sample No. 7391 is suitable for use in concrete provided the sand is washed to remove excess silt, proper gradings are obtained, and low-alkali cement is used.

BIA report no.: BR 20

EL-251
(2-62)

ASSISTANT COMMISSIONER AND CHIEF ENGINEER
DIVISION OF ENGINEERING LABORATORIES
CONCRETE AND STRUCTURAL BRANCH

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION

AGGREGATE ~~RIPRAP~~

STATE	Wyoming	SOURCE NO.	25
LAT.	43° N	LONG.	108° W
REPORT NO. C-	367A	DATE	6-21-50
LAB. SAMPLE NO. M-	104	REC.	6
TYPE OF MATERIAL	Sand and gravel	DATE REC'D.	11-12-47
LTR. TRANSMITTAL	Construction Engineer	DATE	10-31-47
NAME OF DEPOSIT	Muddy Creek		
LOCATION	1 mile north of Muddy Creek		
SW 1/4	SEC. 20	T 4 N	R 4 E
MERIDIAN	Wind River		
OWNERSHIP	U.S. Government		
VOLUME	120,000 cubic yards	OVERBURDEN	Average of 1.5 feet
FEATURE	Wyoming Canal		
PROJECT	Riverton	COMPILED BY	JDR
REMARKS		CHECKED BY	RNH
		REVIEWED BY	
		SUBMITTED BY	

GRADING (DES. 4,5,6) (CUM. % RETAINED)

SIEVE	PIT RUN	3"-1½"	Pit run (~~1½"-¾"~~)	¾"-No.4	Washed FINE AGG.
6 IN.	0				
3½ IN.	--				
3 IN.	0				
2½ IN.	--				
1¾ IN.	--				
1½ IN.	0				
1¼ IN.	--				
⅞ IN.	--				
¾ IN.	23				
⅝ IN.	--				
⅜ IN.	60				
5/16 IN.	--				
NO. 4	100		0		0
NO. 5			--		--
NO. 8			17		28
NO. 16			37		48
NO. 30			56		67
NO. 50			72		80
NO. 100			86		92
PAN			100		100
F.M.	6.83		2.68		315
% SAND	24				

TEST RESULTS

	6"-3"	3-1½	1½-¾	¾-⅜	⅜-No.4	FINE AGG.	WASHED FINE AGG
SP. GR., S.S.D. (DES. 9, 10)	--	--	2.65	2.60	2.57	2.54	2.66
ABSORPTION, PERCENT (DES. 9, 10)	--	--	1.1	1.7	2.4	3.3	1.5
ORGANIC IMPURITIES, COLOR (DES. 14)	—	—	—	—	—	Clear	
PERCENT SILT (DES. 16)						13.9	
PERCENT LIGHTER THAN SP GR.							
CLAY LUMP, % (DES. 13)							
SAND EQUIVALENT	—	—	—	—	—		
Na_2SO_4 LOSS, 5 CYC WGTD % LOSS (DES. 19)	—	—	9.1			—	6.9

L.A ABRASION (DES 21) GRADING	"A"	"B"	"C"	"D"	
% LOSS, 100 REV.	7.0				—
% LOSS 500 REV.	27.3				—

FREEZING AND THAWING DATA

CONCRETE							RIPRAP	
W/C RATIO	SLUMP INCHES	% AIR METER	H_2O LBS/YD^3	28-DAY STR. 3"x6" CYL	WGT. LOSS %	CYCLES	WGT. LOSS % 3 INCH CUBE	CYCLES
	Not	tested						

ALKALI — AGGREGATE REACTIVITY DATA

MATERIALS	SAND				GRAVEL			
CEMENT NO.		Petro only				Petro only		
SODA EQUIVALENT								
TEST AGG %	100	100	50	25	100	100	50	25
EXP % — 6 MO								
EXP % — 12 MO								

PETROGRAPHIC DESCRIPTION: MEMORANDUM NO. 50-60 DATE: 4-19-50 BY: T. R. Magorian

The gravel particles range from angular to subrounded in shape. A few of the particles are coated with sand cemented by calcite. The gravels are composed mainly of limestones, with lesser amounts of quartzites, sandstones, basalts, granites, dacites, andesites, and cherts. The sand particles average subangular in shape and are composed of the same rock types found in the gravels with grains of quartz and calcite found in the finer fractions. Materials deleteriously reactive with high-alkali cement constitute 9 percent of the gravel and 10 percent of the sand. Physically unsound particles constitute 8 percent of the gravels and 10 percent of the sand.

Conclusions: Aggregate comparable to Sample No. M-104 is suitable for use in concrete provided the sand is washed to remove excess silt, proper gradings are obtained, and low-alkali cement is used.

BIA report no.; BR 21

EL-251
(2-62)

ASSISTANT COMMISSIONER AND CHIEF ENGINEER
DIVISION OF ENGINEERING LABORATORIES
CONCRETE AND STRUCTURAL BRANCH

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION

STATE Wyoming	SOURCE NO. 18	AGGREGATE ~~XXXXXX~~	REPORT NO. C-367 DATE 9-16-47
LAT. 43° N	LONG. 108° W		LAB. SAMPLE NO. 7390 REG. 6
TYPE OF MATERIAL	Sand and gravel		DATE REC'D. 11-19-46
LTR. TRANSMITTAL	Acting Project Engineer		DATE 11-13-46
NAME OF DEPOSIT	Burnaugh Pit		
LOCATION			
	SEC. 25, 26 T 4 N	R 4 E	MERIDIAN Wind River
OWNERSHIP	U.S. Government		
VOLUME	Not furnished	OVERBURDEN	Not furnished
FEATURE	Lost Wells Laterals and Wyoming Canal		
PROJECT	Missouri River Basin		COMPILED BY JDP
REMARKS			CHECKED BY RNH
			REVIEWED BY
			SUBMITTED BY

GRADING (DES. 4,5,6) (CUM. % RETAINED)

SIEVE	PIT RUN	3"-1½"	~~1½"-¾"~~ Pit run	¾"-#4	Washed FINE AGG.
6 IN.	0				
3½ IN.	--				
3 IN.	0				
2½ IN.	--				
1¾ IN.	--				
1½ IN.	3				
1¼ IN.	--				
⅞ IN.	--				
¾ IN.	36				
⅝ IN.	--				
⅜ IN.	72				
5/16 IN.	--				
NO. 4	100		0		0
NO. 5			--		--
NO. 8			22		26
NO. 16			41		47
NO. 30			59		68
NO. 50			76		85
NO. 100			86		95
PAN			100		100
F. M.	7.11		2.84		321
% SAND	43				

TEST RESULTS

	6"-3"	3-1½	1½-¾	¾-⅜	⅜-#4	FINE AGG.	WASHED FINE AGG
SP. GR., S.S.D. (DES. 9, 10)			2.64	2.60	2.56	2.57	2.62
ABSORPTION, PERCENT (DES. 9, 10)			1.3	1.8	2.3	3.0	1.8
ORGANIC IMPURITIES, COLOR (DES. 14)	—	—	—	—	—	Clear	--
PERCENT SILT (DES. 16)						17.5	--
PERCENT LIGHTER THAN SP GR.							
CLAY LUMP, % (DES. 13)							
SAND EQUIVALENT	—	—	—	—	—		
Na_2SO_4 LOSS, 5 CYC WGTD % LOSS (DES. 19)	—	—	6.0			—	9.6

L.A. ABRASION (DES 21) GRADING	"A"	"B"	"C"	"D"	
% LOSS, 100 REV.	7.4				—
% LOSS 500 REV.	29.3				—

FREEZING AND THAWING DATA

CONCRETE							RIPRAP	
W/C RATIO	SLUMP INCHES	% AIR METER	H_2O LBS/YD^3	28-DAY STR. 3"x6" CYL	WGT. LOSS %	CYCLES	WGT. LOSS % 3 INCH CUBE	CYCLES
	Not tested							

ALKALI — AGGREGATE REACTIVITY DATA

MATERIALS	SAND				GRAVEL			
CEMENT NO.		Petro only				Petro only		
SODA EQUIVALENT								
TEST AGG %	100	100	80	25	100	100	80	25
EXP % — 6 MO								
EXP % — 12 MO								

PETROGRAPHIC DESCRIPTION: ~~XXXXXXXX~~ Report NO. C-367 DATE: 9-16-47 BY: L. C. Zima

The gravel is predominantly subangular in shape and is composed mainly of cherts, limestones, sandstones, granite, and granite gneisses, with smaller amounts of andesite porphyries and basalt. Physically unsound material constitutes 8 percent and deleteriously reactive particles constitute 39 percent of the gravel.'

The sand is predominantly subangular in shape and is composed mainly of cherts, limestones, sandstones, granite, and granite gneisses. Physically unsound material constitutes 15 percent of the sand.

<u>Conclusions</u>: Although the sand is marginal in the sulfate soundness test, aggregate comparable to Sample No. 7390 is suitable for use in concrete provided the sand is washed to remove excess silt, proper gradings are obtained, and low-alkali cement is used.

BIA report no.: BR 22

EL-251
(2-62)

ASSISTANT COMMISSIONER AND CHIEF ENGINEER
DIVISION OF ENGINEERING LABORATORIES
CONCRETE AND STRUCTURAL BRANCH

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION

AGGREGATE ~~XXXXXXX~~

STATE Wyoming	SOURCE NO. 3	REPORT NO. C-231	DATE 11-5-43
LAT. 43° N	LONG. 108° W	LAB. SAMPLE NO. * See remarks	RES. 6
TYPE OF MATERIAL	Sand and gravel	DATE REC'D. 9-4-43	
LTR. TRANSMITTAL	Associate Engineer		DATE 9-4-43
NAME OF DEPOSIT	Emery Pit		
LOCATION	At Emery Station		
NE 1/4	SEC. 28	T 5 N, R 5 E	MERIDIAN Wind River
OWNERSHIP	Not furnished		
VOLUME	42,000 cubic yards	OVERBURDEN	0 to 1 foot
FEATURE	Boysen Dam		
PROJECT	Missouri River Basin	COMPILED BY	JDR
REMARKS	*Test results shown are an average of	CHECKED BY	RNH
	Samples No. 4994, 4995, 4996	REVIEWED BY	
		SUBMITTED BY	

GRADING (DES. 4,5,6) (CUM. % RETAINED)

SIEVE	PIT RUN	3"-1½"	Pit run	¾"-No.4	Washed FINE AGG.
6 IN.	0				
3½ IN.	--				
3 IN.	0				
2½ IN.	--				
1¾ IN.	--				
1½ IN.	8				
1¼ IN.	--				
⅞ IN.	--				
¾ IN.	39				
⅝ IN.	--				
⅜ IN.	75				
5/16 IN.	--				
NO. 4	100		0		0
NO. 5			--		--
NO. 8			11		14
NO. 16			20		24
NO. 30			30		35
NO. 50			40		47
NO. 100			63		74
PAN			100		100
F.M.	7.22		1.64		1.94
% SAND	51				

TEST RESULTS

	6"-3"	3-1½	1½-¾	¾-⅜	⅜-No.4	FINE AGG.	WASHED FINE AGG.
SP. GR., S.S.D. (DES. 9, 10)	--	2.62	2.64	2.63	2.62	2.60	2.66
ABSORPTION, PERCENT (DES. 9, 10)	--	1.5	1.5	1.8	2.5	3.1	1.3
ORGANIC IMPURITIES, COLOR (DES. 14)	—	—	—	—	—	Clear	
PERCENT SILT (DES. 16)						27.4	
PERCENT LIGHTER THAN SP GR.							
CLAY LUMP, % (DES. 13)							
SAND EQUIVALENT	—	—	—	—	—		
Na_2SO_4 LOSS, 5 CYC WGTD % LOSS (DES. 19)	—	—	13.3			—	16.6
L.A. ABRASION (DES 21) GRADING	"A"	"B"	"C"	"D"			—
% LOSS, 100 REV.	Not tested						—
% LOSS 500 REV.							—

FREEZING AND THAWING DATA

CONCRETE: W/C RATIO	SLUMP INCHES	% AIR METER	H_2O LBS/YD^3	28-DAY STR. 3"x6" CYL.	WGT. LOSS %	CYCLES	RIPRAP: WGT. LOSS % 3 INCH CUBE	CYCLES
	Not tested							

ALKALI - AGGREGATE REACTIVITY DATA

MATERIALS	SAND				GRAVEL			
CEMENT NO.		Petro only				Petro only		
SODA EQUIVALENT								
TEST AGG %	100	100	50	25	100	100	50	25
EXP % - 6 MO								
EXP % - 12 MO								

PETROGRAPHIC DESCRIPTION: ~~XXXXXXXX~~ Report NO. C-231 DATE: 11-5-43 BY: R. C. Mielenz

The gravel is composed predominantly of limestone and sandstone; massive chalcedonic cherts comprise about 3 percent of the gravel. About 2 percent of the gravel is physically unsound. The sand, subangular to angular in shape, is composed of the same rock types found in the gravel, quartz, and feldspars. About 10 to 20 percent of the sand is physically unsound.

Conclusions: Aggregate comparable to Samples No. 4994, 4995, and 4996 is unsuitable for use in concrete.

BIA report no.: BR 23

EL-251
(2-62)

ASSISTANT COMMISSIONER AND CHIEF ENGINEER
DIVISION OF ENGINEERING LABORATORIES
CONCRETE AND STRUCTURAL BRANCH

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION

STATE	Wyoming	SOURCE NO.	11	AGGREGATE ~~RIPRAP~~	REPORT NO. C- 303A
LAT.	43° N	LONG.	108° W	DATE	4-11-46
TYPE OF MATERIAL	Sand and gravel	LAB. SAMPLE NO.	*	REG.	6
LTR. TRANSMITTAL	Engineer, Paul Berg	DATE REC'D.	12-11-45	DATE	11-26-45
NAME OF DEPOSIT	Area "J"				
LOCATION	On Big Horn River in Fremont County on west side of CB&Q Railroad				
	N 1/2 SEC. 10	T 4 N	R 6 E	MERIDIAN	Wind River
OWNERSHIP	Not furnished				
VOLUME	Not furnished	OVERBURDEN	Not furnished		
FEATURE	Boysen Dam				
PROJECT	Missouri River Basin	COMPILED BY	JDR		
REMARKS	*Samples No. 6564, 6566, 6567, and 6568. Results shown are an average.	CHECKED BY	RHH		
	1/ Information not available.	REVIEWED BY			
		SUBMITTED BY			

GRADING (DES. 4,5,6) (CUM. % RETAINED)

SIEVE	PIT RUN	3-1½"	1½-¾	¾-#4	FINE AGG.
6 IN.	0				
3½ IN.	--				
3 IN.	0				
2½ IN.	--				
1¾ IN.	--				
1½ IN.	0				
1¼ IN.	--				
7/8 IN.	--				
¾ IN.	49				
5/8 IN.	--				
3/8 IN.	84				
5/16 IN.	--				
NO. 4	100				0
NO. 5					--
NO. 8					3
NO. 16					9
NO. 30					44
NO. 50					77
NO. 100					93
PAN					100
F.M.	7.33				226
% SAND	1/				

TEST RESULTS

	6"-3"	3-1½	1½-¾	¾-3/8	3/8-#4	FINE AGG.	WASHED FINE AGG.
SP. GR., S.S.D. (DES. 9, 10)	--	--	2.72	2.62	2.62	2.64	1/
ABSORPTION, PERCENT (DES. 9, 10)	--	--	1.3	1.5	1.5	1.5	1/
ORGANIC IMPURITIES, COLOR (DES. 14)	—	—	—	—	—	Clear	—
PERCENT SILT (DES. 16)						4.4	
PERCENT LIGHTER THAN SP GR.							
CLAY LUMP, % (DES. 13)							
SAND EQUIVALENT	—	—	—	—	—		
NA_2SO_4 LOSS, 5 CYC WGTD % LOSS (DES. 19)	—	—		7.1		—	4.5

L.A. ABRASION (DES 21) GRADING	"A"	"B"	"C"	"D"	
% LOSS, 100 REV.	5.8				—
% LOSS 500 REV.	24.8				—

FREEZING AND THAWING DATA

CONCRETE							RIPRAP	
W/C RATIO	SLUMP INCHES	% AIR METER	H_2O LBS/YD^3	28-DAY STR. 3"x6" CYL.	WGT. LOSS %	CYCLES	WGT. LOSS % 3 INCH CUBE	CYCLES
	Not tested							

ALKALI — AGGREGATE REACTIVITY DATA

MATERIALS	SAND				GRAVEL			
CEMENT NO.		Petro only				Petro only		
SODA EQUIVALENT								
TEST AGG %	100	100	50	25	100	100	50	25
EXP % — 6 MO								
EXP % — 12 MO								

PETROGRAPHIC DESCRIPTION: ~~MEMORANDUM~~ Report NO. C-303A . DATE: 4-11-46 . BY: R. H. Cook, L. C. Zima

Gravel pebbles are predominantly subround and are composed of granites, granite gneisses, quartzites, basalts, and andesite porphyries; hard sandstones, trachytes, andesites, limestones and chalcedonic cherts occur in smaller proportions. Glossy to aphanitic trachytes and andesites, and chalcedonic cherts which may be deleteriously reactive with high-alkali cements constitute a significant proportion of the gravels tested.

The coarse sand fractions are composed predominantly of the rock types observed in the gravels. The fine fractions of the sands are composed of independent grains of quartz and feldspar.

Conclusions: Aggregate comparable to Samples No. 6564, 6566, 6567, and 6568 is suitable for use in concrete provided the sand is washed to remove excess silt, proper gradings are obtained, and low-alkali cement is used.

BIA report no.: BR 24

EL-251
(2-62)

ASSISTANT COMMISSIONER AND CHIEF ENGINEER
DIVISION OF ENGINEERING LABORATORIES
CONCRETE AND STRUCTURAL BRANCH

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION

AGGREGATE ~~RIPRAP~~

STATE Wyoming	SOURCE NO. 4	REPORT NO. C- 231	DATE 11-5-43
LAT. 43° N	LONG. 108° W	LAB. SAMPLE NO. 4997,4998*	REG. 6
TYPE OF MATERIAL	Sand and gravel	DATE REC'D. 9-4-43	
LTR. TRANSMITTAL	Associate Engineer		DATE 9-4-43
NAME OF DEPOSIT	Tuff Creek		
LOCATION	1/2 mile south of Tuff Creek along CB&Q Railroad		
	SW 1/4 SEC. 10 T 4 N R 6 E	MERIDIAN Wind River	
OWNERSHIP	Not furnished		
VOLUME	462,220 cubic yards	OVERBURDEN 0 to 1 foot	
FEATURE	Boysen Dam		
PROJECT	Missouri River Basin	COMPILED BY JDR	
REMARKS	*Test results shown are an average for the two samples.	CHECKED BY RNH	
		REVIEWED BY	
		SUBMITTED BY	

GRADING (DES. 4,5,6) (CUM. % RETAINED)

SIEVE	PIT RUN	3"-1½"	Pit run (~~1½"-¾"~~)	¾"-#4	Washed FINE AGG.
6 IN.	0				
3 ½ IN.	--				
3 IN.	0				
2 ½ IN.	--				
1 ¾ IN.	--				
1 ½ IN.	13				
1 ¼ IN.	--				
⅞ IN.	--				
¾ IN.	60				
⅝ IN.	--				
⅜ IN.	87				
5/16 IN.	--				
NO. 4	100		0		0
NO. 5			--		--
NO. 8			7		7
NO. 16			16		18
NO. 30			40		41
NO. 50			73		74
NO. 100			90		94
PAN			100		100
F. M.	7.60		2.26		2.34
% SAND	49				

TEST RESULTS

	6"-3"	3-1½	1½-¾	¾-⅜	⅜-#4	FINE AGG.	WASHED FINE AGG.
SP. GR., S.S.D. (DES. 9, 10)	--	2.62	2.62	2.61	2.59	2.64	2.69
ABSORPTION, PERCENT (DES. 9, 10)	--	0.8	1.2	1.5	1.9	1.8	0.5
ORGANIC IMPURITIES, COLOR (DES. 14)	—	—	—	—	—	Clear	
PERCENT SILT (DES. 16)						6.7	
PERCENT LIGHTER THAN SP GR.							
CLAY LUMP, % (DES. 13)							
SAND EQUIVALENT	—	—	—	—	—		
NA_2SO_4 LOSS, 5 CYC WGTD % LOSS (DES. 19)	—	—	4.4			—	4.0

L.A. ABRASION (DES 21) GRADING	"A"	"B"	"C"	"D"	
% LOSS, 100 REV.	Not tested				—
% LOSS 500 REV.					—

FREEZING AND THAWING DATA

CONCRETE W/C RATIO	SLUMP INCHES	% AIR METER	H_2O LBS/YD³	28-DAY STR. 3"x6" CYL.	WGT. LOSS %	CYCLES	RIPRAP WGT. LOSS % 3 INCH CUBE	CYCLES
	Not tested							

ALKALI — AGGREGATE REACTIVITY DATA

MATERIALS	SAND				GRAVEL			
CEMENT NO.	Petro only				Petro only			
SODA EQUIVALENT								
TEST AGG %	100	100	50	25	100	100	50	25
EXP % — 6 MO								
EXP % — 12 MO								

PETROGRAPHIC DESCRIPTION: ~~MEMORANDUM~~ Report NO. C-231 DATE: 11-5-43 BY: R. C. Mielenz

The gravel is physically sound and composed predominantly of granites, gneisses, intermediate to basic igneous rocks, and sandstones. Chalcedonic cherts constitute about 4.5 percent of the gravel. The sand, angular to subangular in shape, is composed of the same rock types found in the gravel, quartz, and feldspars. About 5 to 10 percent of the sand is physically unsound.

Conclusions: Aggregate comparable to Samples No. 4997 and 4998 is suitable for use in concrete provided the sand is washed to remove excess silt and proper gradings are obtained.

BIA report no.: BR 25

EL-251
(2-62)

ASSISTANT COMMISSIONER AND CHIEF ENGINEER
DIVISION OF ENGINEERING LABORATORIES
CONCRETE AND STRUCTURAL BRANCH

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF RECLAMATION

AGGREGATE ~~XXXXXXX~~

STATE Wyoming	SOURCE NO. 26	REPORT NO. C- 367A	DATE 6-21-50
LAT. 43° N	LONG. 108° W	LAB. SAMPLE NO. M- 105*	REG. 6
TYPE OF MATERIAL Sand and gravel		DATE REC'D. 11-12-47	
LTR. TRANSMITTAL Construction Engineer			DATE 10-31-47
NAME OF DEPOSIT Krump			
LOCATION NW 1/4	SEC. 32	T 4 N, R 6 E	MERIDIAN Wind River
OWNERSHIP U.S. Government			
VOLUME 40,000 cubic yards	OVERBURDEN Average of 2 feet		
FEATURE Wyoming Canal			
PROJECT Riverton		COMPILED BY JDR	
REMARKS *M-105 and M-105A are from the same source. Results shown are for M-105		CHECKED BY RNH	
		REVIEWED BY	
		SUBMITTED BY	

GRADING (DES. 4,5,6) (CUM. % RETAINED)

SIEVE	PIT RUN	3"-1½"	Pit run (1½"-¾" XXXX)	¾"-#4	Washed (FINE AGG.)
6 IN.	0				
3½ IN.	--				
3 IN.	0				
2½ IN.	--				
1¾ IN.	--				
1½ IN.	1				
1¼ IN.	--				
⅞ IN.	--				
¾ IN.	46				
⅝ IN.	--				
⅜ IN.	83				
5/16 IN.	--				
NO. 4	100		0		0
NO. 5			--		--
NO. 8			10		12
NO. 16			25		29
NO. 30			47		54
NO. 50			71		78
NO. 100			89		94
PAN			100		100
F. M.	7.30		2.42		2.67
% SAND	50				

TEST RESULTS

	6"-3"	3-1½	1½-¾	¾-⅜	⅜-#4	FINE AGG.	WASHED FINE AGG.
SP. GR., S.S.D. (DES. 9, 10)	--	--	2.60	2.58	2.57	2.58	2.67
ABSORPTION, PERCENT (DES. 9, 10)	--	--	0.9	1.4	1.7	1.6	0.7
ORGANIC IMPURITIES, COLOR (DES. 14)	—	—	—	—	—	Clear	
PERCENT SILT (DES. 16)						6.3	
PERCENT LIGHTER THAN SP GR.							
CLAY LUMP, % (DES. 13)							
SAND EQUIVALENT	—	—	—	—	—		
Na_2SO_4 LOSS, 5 CYC WGTD % LOSS (DES. 19)	—	—	4.6			—	4.2
L.A. ABRASION (DES 21) GRADING	"A"	"B"	"C"	"D"			—
% LOSS, 100 REV.	4.8						—
% LOSS 500 REV.	22.4						—

FREEZING AND THAWING DATA

CONCRETE: W/C RATIO	SLUMP INCHES	% AIR METER	H_2O LBS/YD³	28-DAY STR. 3"x6" CYL	WGT. LOSS %	CYCLES	RIPRAP: WGT. LOSS % 3 INCH CUBE	CYCLES
	Not tested							

ALKALI — AGGREGATE REACTIVITY DATA

MATERIALS	SAND				GRAVEL			
CEMENT NO.		Petro only				Petro only		
SODA EQUIVALENT								
TEST AGG %	100	100	50	25	100	100	50	25
EXP % — 6 MO								
EXP % — 12 MO								

PETROGRAPHIC DESCRIPTION: MEMORANDUM NO. 50-60 DATE: 4-19-50 BY: T. R. Magorian

The gravel particles average subround in shape. A few of the particles are coated with sand cemented by calcite. The gravel is composed mainly of basalts, with lesser amounts of limestones, quartzites, granites, sandstones, andesites, dacites, cherts, and quartz and feldspar grains. The sand particles average subangular in shape and are composed of the same rock types found in the gravels with lesser amounts of grains of quartz, calcite, feldspars, siliceous glass, and basaltic glass in the finer fractions. Materials deleteriously reactive with high-alkali cement constitute 15 percent of the gravel and 10 percent of the sand. Physically unsound particles constitute 2 percent of the gravel and 5 percent of the sand.

Conclusions: Aggregate comparable to Sample No. M-105 is suitable for use in concrete provided the sand is washed to remove excess silt, proper gradings are obtained, and low-alkali cement is used.

Sand/Gravel, Gypsum, and Iron Resources on the Wind River Indian Reservation, Wyoming

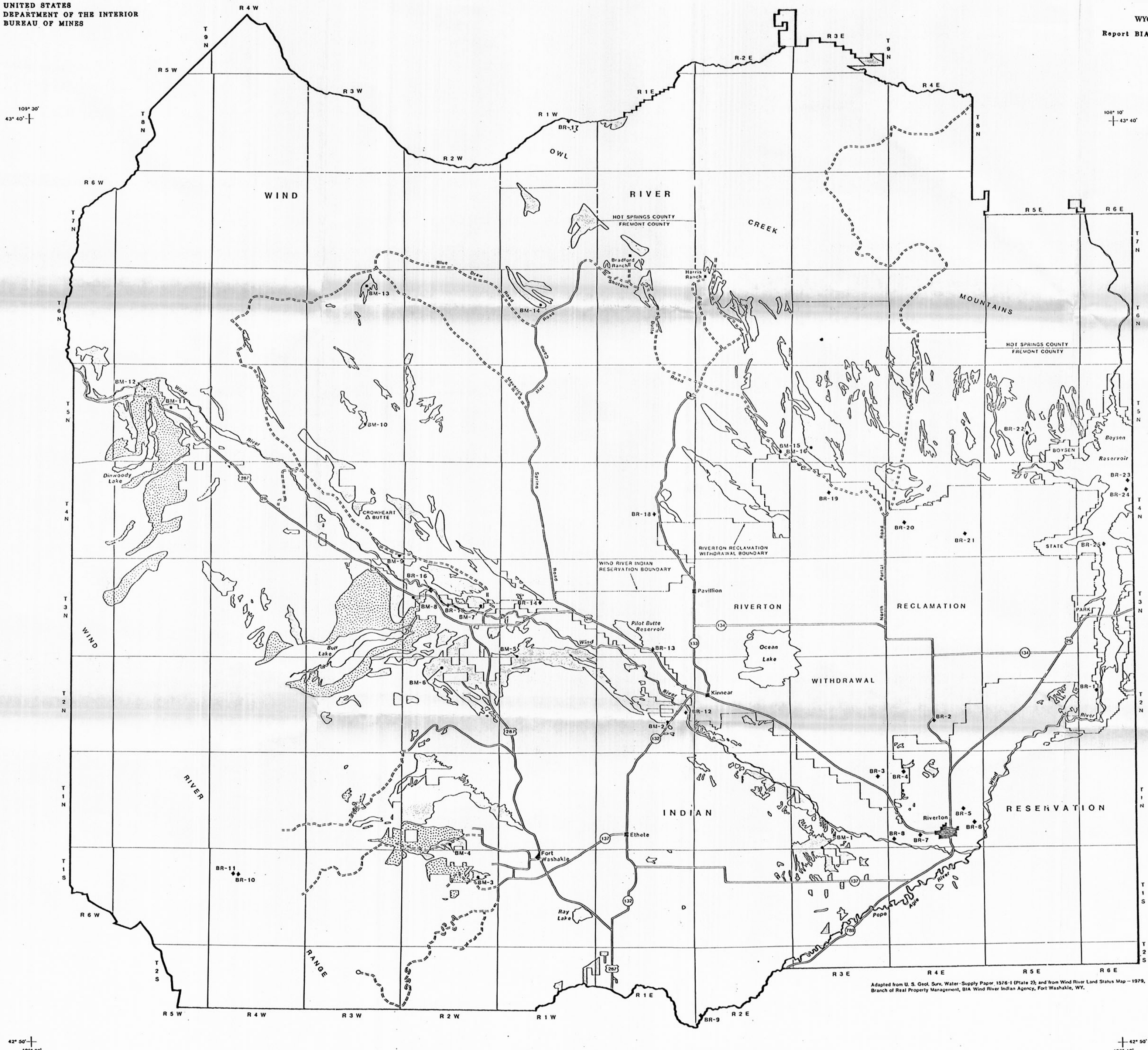
R 61

WYOMING STATE GEOLOGICAL SURVEY 1933

Geology -- Interpreting the past to provide for the future

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF MINES

WYOMING STATE GEOLOGICAL SURVEY
REPRINT 61
Report BIA No. 8-II, Part 2 (Wind River) PLATE 1



EXPLANATION

BM-12 Locality of 1 of 16 sand and gravel samples taken by the Bureau of Mines

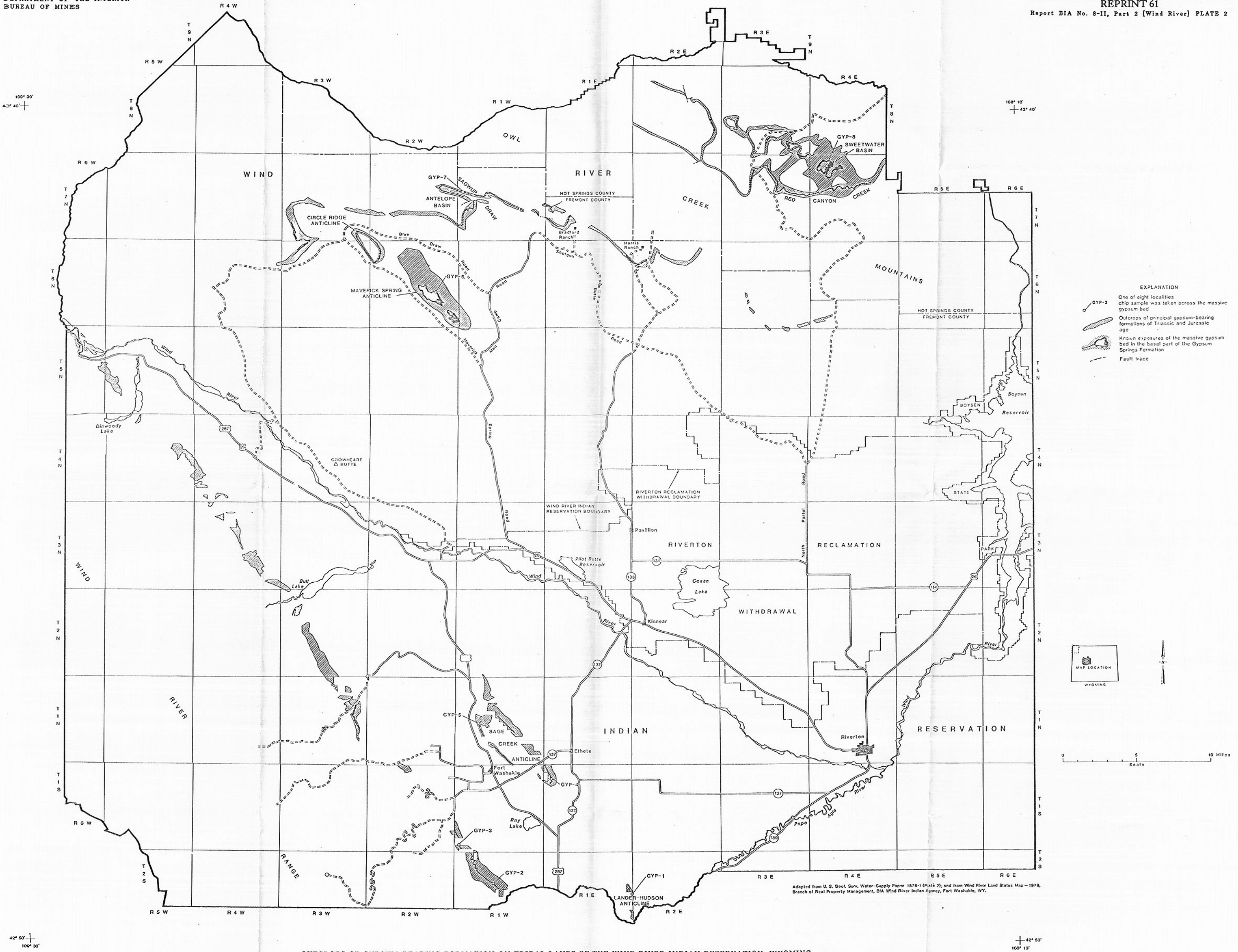
BR-12 Locality of 1 of 25 aggregate samples analyzed by the Bureau of Reclamation

Terrace and pediment deposits of Quaternary age

Glacial deposits of Quaternary age

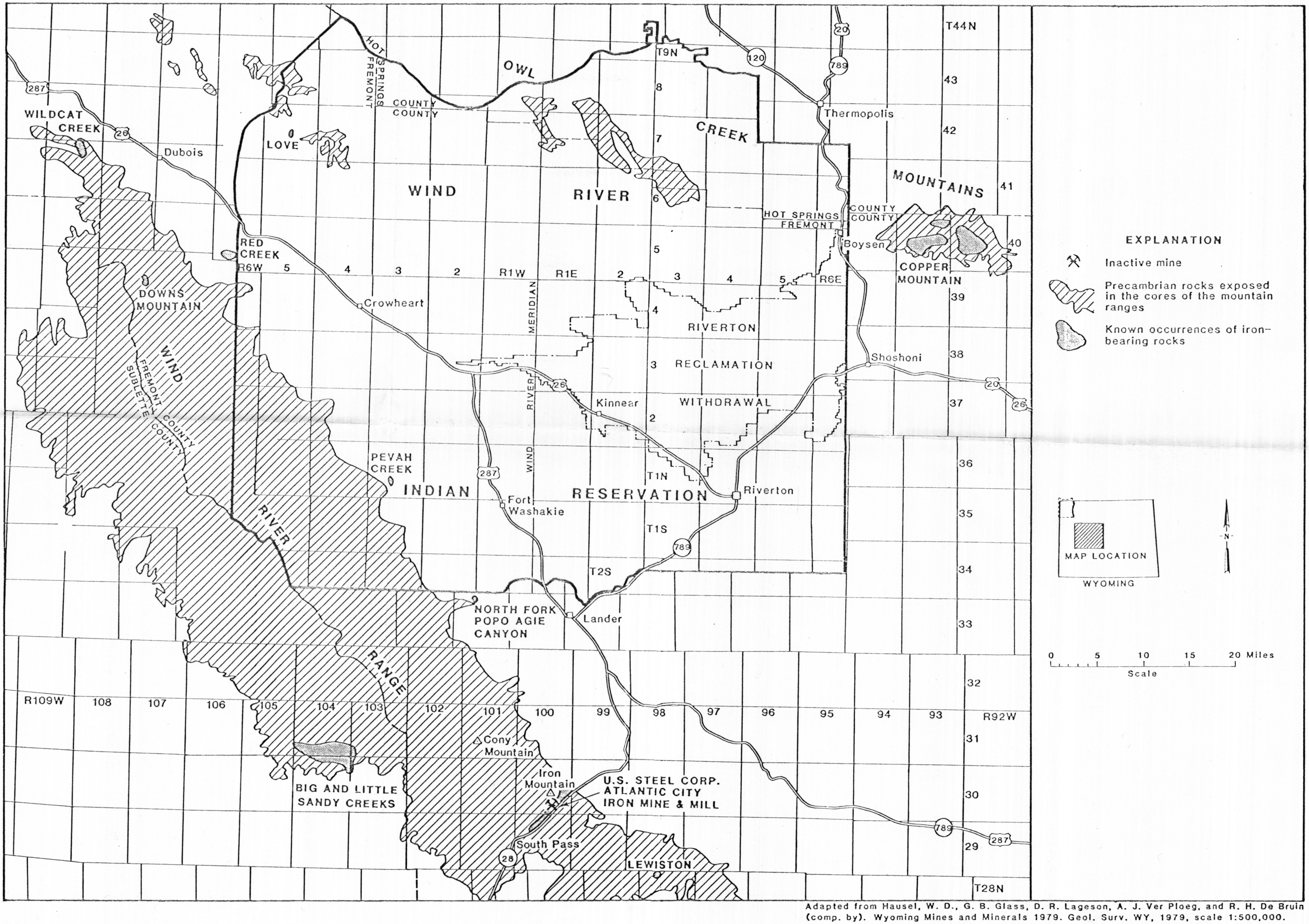
NOTE: Only larger terrace, pediment, and glacial deposits on tribal land are shown on this map; and it is not purported to show every potential sand and gravel source on the reservation. In some areas, the Wind River Formation may contain conglomeratic lenses that might be used as sources of sand and gravel locally. Recent sand and gravel deposits along the master stream, the Wind River, and its tributaries are not shown because they have not been mapped as a distinct unit within alluvium of the flood plain and because most of them are on privately owned land.

SAND AND GRAVEL DEPOSITS ON TRIBAL LANDS OF THE WIND RIVER INDIAN RESERVATION, WYOMING



OUTCROPS OF GYPSUM-BEARING FORMATION ON TRIBAL LANDS OF THE WIND RIVER INDIAN RESERVATION, WYOMING

UNITED STATES
DEPARTMENT OF THE INTERIOR
BUREAU OF MINES



Adapted from Hausel, W. D., G. B. Glass, D. R. Lageson, A. J. Ver Ploeg, and R. H. De Bruin (comp. by). Wyoming Mines and Minerals 1979. Geol. Surv. WY, 1979, scale 1:500,000.

IRON OCCURRENCES ON OR NEAR THE WIND RIVER INDIAN RESERVATION, WYOMING