OPERATING PERMIT APPLICATION

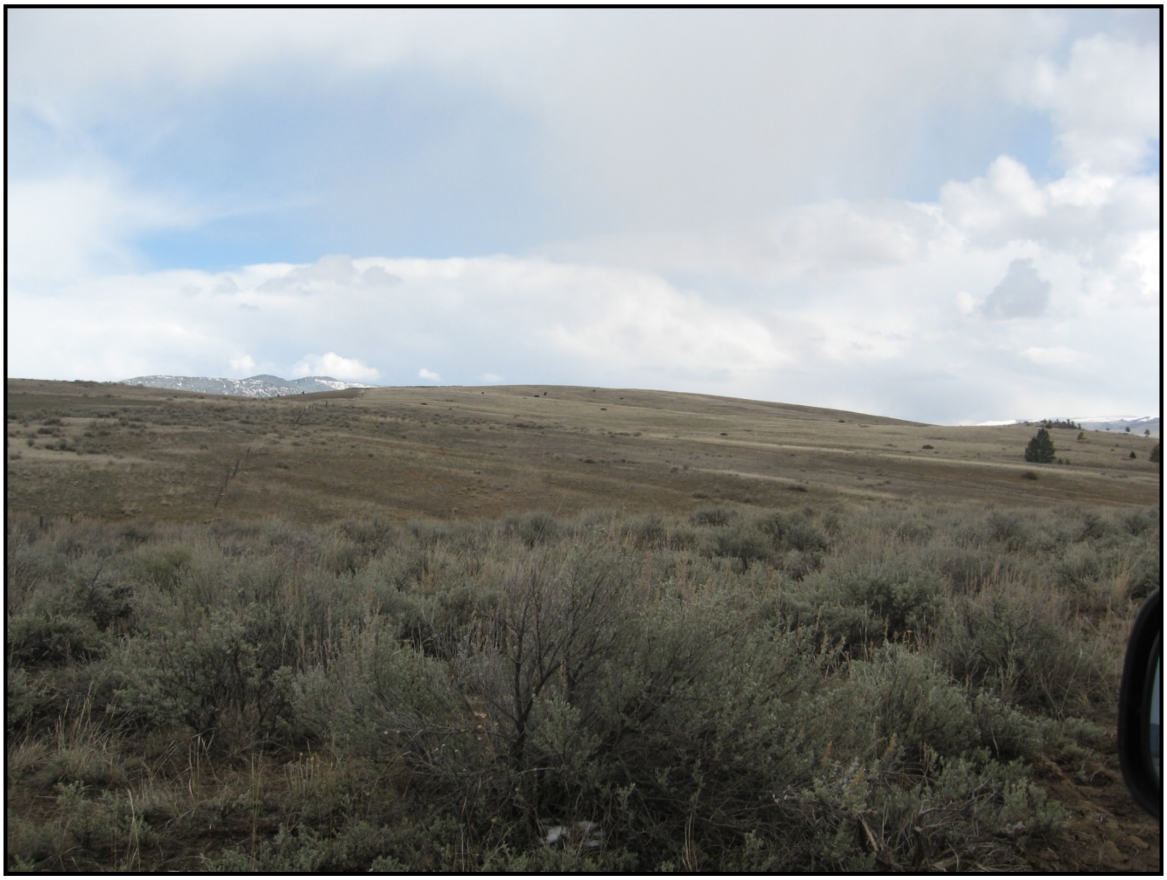
MONTANA LIMESTONE RESOURCES

APPENDIX A-6

BASELINE GEOLOGY REPORT

October, 2014

GEOLOGY OF
MONTANA LIMESTONE RESOURCES'
HIGH CALCIUM LIMESTONE DEPOSIT
NEAR DRUMMOND, MONTANA



View of study area looking northeast towards rolling hills where limestone ore is exposed at surface.

By

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INTRODUCTION

This report provides a summary of the geology exposed in the study area for the Montana Limestone Resources project near Drummond in Granite County, Montana. The section includes descriptions of the regional structural setting and the stratigraphic units found within the study area, based on literature review and geologic field investigations conducted in the study area 2008 through mid-2014.

Regional Structural Geology

The study area is within the Montana Fold and Thrust Belt, an area of complex faulting and folding in western Montana formed by continental plate collisions on the west coast of North America that began in the late Cretaceous. In addition, the Drummond area falls within a structural zone called the Lewis and Clark Line. The Lewis and Clark Line is a lineament that bisects the Montana Fold and Thrust Belt, with thrust sheets experiencing different rotational movements north of the line than the thrust sheets to the south. Note how the thrust fault traces are offset from each other along the Lewis and Clark Line in Figure 1.

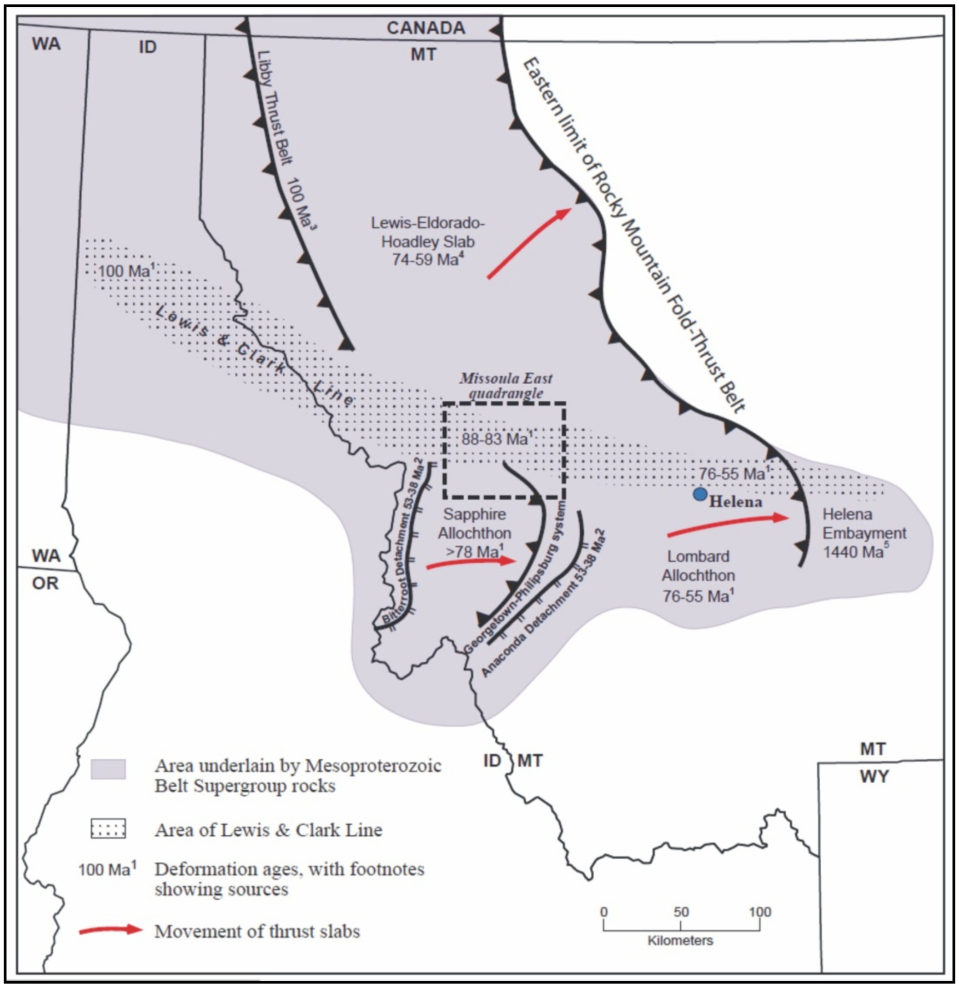

Figure 1: Regional structure of western Montana showing the relationship of Missoula East Quadrangle to the Lewis and Clark Lineament and the Montana Fold and Thrust Belt. The permit area is located at the east end of the Missoula East Quadrangle outline shown above (Lonn, et. al., 2010)

The Lewis and Clark Line is characterized by broad anticlines and synclines, which have allowed the Mississippian Madison limestones to be exposed at the surface in many places (see Figure 2, light blue outcrop pattern). The permit area is located on one of these broad anticlines, west of Drummond.

Stratigraphy

A wide variety of formations ranging from Mississippian limestones to Quaternary gravels occur in the study area. Figure 2 shows the approximate location of the permit area with respect to the regional geology of the area. Note that because of the anticlinal structure on the study area, the Mississippian limestones are exposed at the surface, while the younger formations outcrop off-structure to the northeast and southwest. The limestone orebody of interest occurs within the Mission Canyon Formation of the Mississippian-age Madison Group. Formations that occur within the study area are described below, in order of age from youngest to oldest. Map codes corresponding to Figure 2 are in parentheses following each formation or unit name.

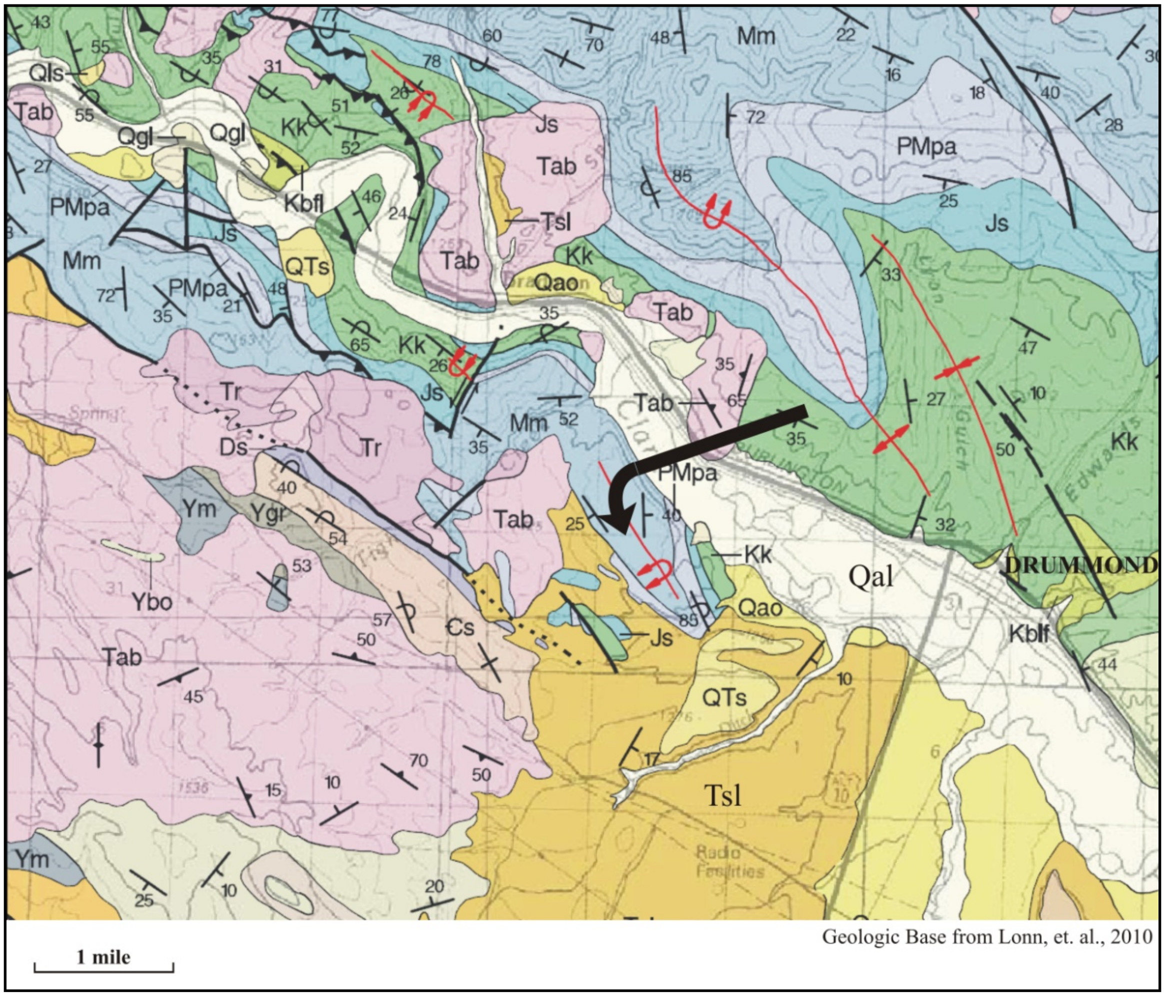

Figure 2: Geologic map of the area. Arrow indicates approximate location of permit area. Geologic base is from the Missoula East 30’ x 60’ quadrangle by Lonn, et. al. (2010). Mm= Mississippian Madison Group; PMpa= Permian through Mississippian Phosphoria-Quadrant-Amsden Formations undivided; Js=Jurassic Morrison and Swift (Ellis) undivided; Kk=Lower Cretaceous Kootenai Formation; Tab=Tertiary Andesite/basalt; Tr= Tertiary rhyolite, Tsl= Lower Tertiary sediments (including Renova Fm); QTs=Older Pleistocene to Tertiary gravels, Qao= Quaternary gravel & sand above modern side streams; Qal= Quaternary alluvium of modern streams.

CENOZOIC

Quaternary

Alluvium (Qal) – The most recent Quaternary deposits are modern floodplain alluvium deposits along the north side of the study area near the Clark Fork River. They contain well–sorted to-moderately well-sorted gravels and sands. The water table is quite high near the river in this unit.

Older Alluvium (Qao) – The lower elevations of the study area also contain moderately-sorted, older gravel, sand, and silt perched on terraces above modern streams. Most of the irrigated fields on the study area are developed in these deposits (Figure 2). The deposits are up to 30 feet thick.

Alluvial Terraces (Qat) – Localized gravel terraces are recognized overlying older alluvial gravels along the Clark Fork River. The deposits are either Pleistocene or Tertiary in age and may correlate with the Upper Tertiary Sixmile Creek Formation, forming a thin veneer on top of the Tertiary Renova deposits on the east side of the study area. The gravel is moderately well-sorted and is less than 30 feet thick.

Tertiary

These units are important as they occur in some the areas of the proposed plant site.

Sixmile Creek Formation (Tsm) – These sediments are characterized by poorly to moderately sorted conglomerates of the Upper Tertiary containing locally derived subangular to subrounded boulders and cobbles in a sandy to silty matrix interbedded with sandstone and siltstone. Siltstone units can contain a discontinuous bed of white, well cemented ash which resembles porcelain. Basal beds are typified by well rounded to subrounded gravels, moderately sorted, forming a polymictic conglomerate up to six feet thick which unconformably overlays the Renova Formation. Debris flows are recognized locally. Thickness of the unit is usually less than 30 feet (Porter).

Middle Miocene Unconformity- The contact between the Sixmile Creek Formation and The Renova Formation can expose a laterally discontinuous laterite layer found in the upper part of the exposed Renova Formation. The reddish orange, lithic wacke immediately underlies the gravel unit at the base of the Sixmile Creek Formation.

Renova Formation (Tsl) –The Lower Tertiary is represented on the study area by the Renova Formation. It covers a large part of the east, south and southwestern side of the study area. It consists of mostly white to light gray siltstone, arkosic sandstone, tuffaceous sandstone and volcanic ash deposited in fluvial and lacustrine environments. It can often be recognized at the surface by the presence of white ash mixed in with the soil

(Figure 3). Outcrops of it are characterized by a white to light gray "popcorn-looking soil" due to swelling and shrinking as the bentonitic clays within it wet and dry. The swelling nature of the clays makes this formation difficult for construction sites. The thickness of the Renova varies, but can be up to 150 feet thick.

The base of the Renova contains thin coal seams which were mined sporadically in the early 1900's according to Pardee (1911). The coal was reported to be up to five feet thick here, dipping 10 degrees SW. Numerous small faults and water issues supposedly prevented widespread continuation of mining.

Figure 3: Photograph of typical Renova Formation outcrop in NW¼NW¼, Section 35, T11N, R13W.

Tertiary Volcanics (Tab and Tr) – Both Tertiary rhyolite and andesite/basalt flows have been mapped on the southwest portion of the study area. These volcanics are considered older than the Tertiary sediments described above. The rhyolite contains small black quartz and sanidine crystals and some tuffs are found encased in the flows. The volcanics are thought to be Eocene in age.

MESOZOIC

Cretaceous

Kootenai Formation (Kk)– A fairly thick section of Kootenai Sandstone outcrops on the northeast side of the study area. Some poorly exposed outcrops of Kootenai can also be seen on the south side of the study area in some of the deeper coulees.

The Kootenai is normally divided into four mappable members in the Drummond area (Kauffman, 1963): a lower clastic member, a lower calcareous member, an upper clastic member and an upper calcareous member. The upper calcareous member is often known as the "gastropod limestone" because it is composed almost entirely of gastropod shells in recystallized calcite.

Only the clastic members are well-exposed on the study area. The calcareous members presumably occur on the study area, but are grass-covered. A small quarry used by the ranch operation on the study area is in the upper clastic member along eastern limb of the anticline.

The upper clastic member of the Kootenai is a "salt-and-pepper" sandstone due to the white quartz and black chert grains which make up most of the rock. The rock in the existing small quarry site is very hard, and has an overall reddish tinge, which is typical for the Kootenai. This member is generally the thickest of the four Kootenai members and Kaufmann (1963) measured it as 440' thick.

The lower clastic member outcrops near the intersection of the lower roads on the east side of the study area. The lower member often contains a white quartzite sandstone zone, which often marks the base of the formation. The lower clastic member is 50-75 feet thick.

Jurassic Sediments, undivided (Js) – The Jurassic section is exposed in several places on the study area, but the exposures are so limited, individual formations have not been mapped. The top of the section can contain a sandstone with plant debris preserved on bedding planes. Beneath it is a brown to yellowish brown, often calcareous and glauconitic, "salt and pepper" sandstone (**Swift Sandstone)** with interbedded siltstone and micaeous shale. Minor fossils include oyster, belemnite, and wood fragments. The middle part of the Jurassic section contains a dark brownish gray to dark gray calcareous shale, shaly limestone and limestone (**Rierdon Formation**) which is often identified by the presence of *Gryphaea* oyster shell fossils. These shales weather yellowish gray or whitish gray and are often grass-covered on the study area. A basal, oolitic or sandy limestone bed which characteristically weathers to a gritty surface may also be exposed as part of the Rierdon section.

The lower part of the Jurassic section is dark gray to black, fossiliferous, calcareous buff-weathering siltstone, and argillaceous limestone that weathers creamy white (**Sawtooth Formation equivalent**). This part of the Jurassic is poorly exposed on the study area. Overall, the Jurassic section is about 400 feet thick.

PALEOZOIC

Permian

Phosphoria Formation (Pp) – A major erosional unconformity occurs between the Middle Jurassic and the Permian in southwest Montana. The Phosphoria is poorly exposed on the study area but traces of it can be found in coulees and grass-covered slopes along the northeast flank of the major anticline running through the study area. It can be identified by dark brown phosphatic sandstone, chert and black shale. The formation is about 150 feet thick.

Pennsylvanian

Quadrant Formation (IPq) – The Quadrant is a very hard, light gray to pink, well-sorted, vitreous, silica-cemented quartz sandstone. It forms extremely resistant hogbacks and ridges (IPq in Figure 4 below). It is up 150 feet thick and outcrops on both sides of the anticline.

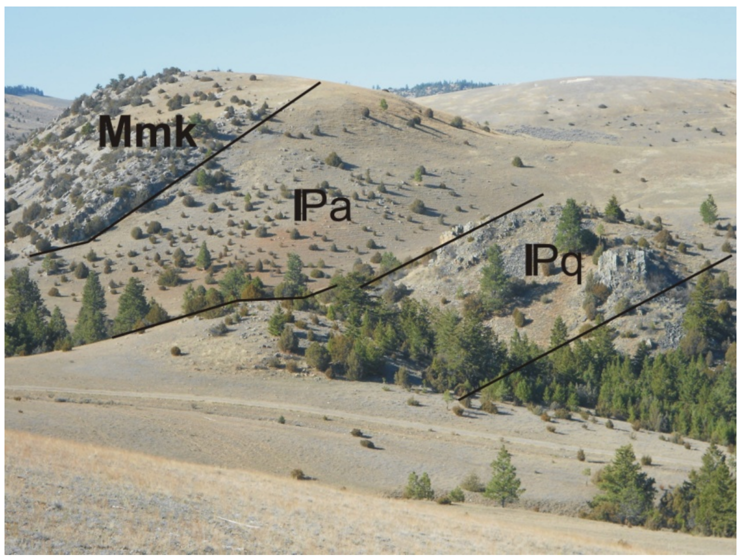

Figure 4: Outcrop pattern from main study area access road along NE flank of anticline, looking west, showing resistant Quadrant quartzite (**IPq**) and Mississippian McKenzie Canyon (**Mmk**) limestone outcrops. The Pennsylvanian Amsden (**IPa**) is less resistant to weathering, but gives a reddish tinge to the soils and grasslands.

Amsden Formation (IPa) – The Amsden is a dark-reddish brown calcareous siltstone, mudstone shale and sandstone. It is generally a slope former, usually marked by reddish soil, but outcrops on both sides of the anticline. It contains a middle zone of gray limestone. It is about 200 feet thick.

Mississippian

Madison Group

The Madison Group is a set of three primarily carbonate formations in the Mississippian. It consists of from top to bottom, the McKenzie Canyon, Mission Canyon, and Lodgepole Formations. The limestone ore of interest is within the lower Mission Canyon Formation.

McKenzie Canyon Formation (Madison Group, Mmk) – The McKenzie Canyon is the uppermost formation of the Mississippian Madison Group. It is a medium to thick bedded limestone and forms prominent cliffs at the southeast-plunging nose of the anticline on the study area (Fig. 4). It consists of grey, medium-grained limestone beds that are often brecciated due to solution/cave collapse. In addition to the characteristic breccia, the formation contains numerous red–stained fractures, which are laced throughout the unit. In some places the breccia is locally silicified. The formation is about 220' thick.

Mission Canyon Formation (Madison Group, Mmc) – The Mission Canyon Formation, the principal target of the proposed Project, is a light to dark grey, thick-bedded limestone with dolomitic intervals. Total thickness of the Mission Canyon is about 400 feet. The upper 160'-180' is dolomitic. The lower 220 feet contains the highly resistant high-calcium limestone ore zone.

> **Dolomitic Unit:** The upper dolomitic unit is a medium-bedded, fine-grained dolomite, dove-grey in color. The dolomite is extremely hard and contains scattered black chert layers. Some of this overburden material will have to be stripped off to access the high-calcium limestone ore in some of the deeper parts of the quarry. The unit is 160-180 feet thick.
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> **Lower High-Calcium Ore Unit:** The lower unit of the Mission Canyon is massively-bedded and is about 220 feet thick. It is exposed on the surface of the gently-dipping SW flank of the anticline running through the study area. The ore zone can be identified by the dark grey medium-grained crystalline nature on broken surfaces. In outcrop the lower ore zone can be identified by pitted weathered surfaces.

Lodgepole Formation (Madison Group, Mml) – The Lodgepole underlies the Mission Canyon and is the lowest formation of the Madison Group. It outcrops on the crest of the anticline where the overlying McKenzie Canyon and Mission Canyon Formations have been eroded off. The Lodgepole will not be mined in this operation, but some of the waste dolomite material may be stockpiled on the Lodgepole outcrop.

It is easily recognized on outcrop by its thin bedding, compared to the massive bedding of the overlying Mission Canyon. The Lodgepole is a light to dark grey argillaceous limestone that is fine-grained (micrite) with interbedded silty clay, yellow shale, and silty limestone, and numerous interbeds of black chert. It is also is characterized by a peculiar erosional pattern which creates limestone pillars. This pattern is the result of numerous calcite veins which fill regularly-spaced fractures in the Lodgepole, but which weathers out much more easily than the surrounding limestone on outcrop.

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