SURFACE MINING (OPEN PIT)
KEY

Terminology
Define the following terms as they relate to mining.

Area mining/strip mining - open cut or open pit surface mining that is carried on the level or along the prevailing topography in which relatively large tracts are disturbed. Usually mined with large shovels or draglines.

Quarry – any open or surface workings, usually for the extraction of sand and gravel, building stone, slate, or limestone.

Surface mining (strip mining) – a procedure of mining that entails the complete removal of overburden material; may generally refer to either an area and/or a contour mine.

Overburden – material of any nature, consolidated or unconsolidated, that overlies a deposit of useful and minable materials or ores, especially those deposits that are mined from the surface by open cuts or pits.

Aggregates – a mass or body of rock particles, mineral grains, or a mixture of both; any of several hard, inert materials, such as sand, gravel, slag, or crushed stone, mixed with a cement or bituminous material to form concrete, mortar, or plaster, or used alone, as in railroad ballast or graded fill. The term can include rock material used as chemical or metallurgical fluxstone.

Alluvium – soil or sediment transported and deposited by flowing water.

Placer – a deposit of sand and gravel containing valuable metals such as gold, tin or diamonds.

Dredging – frequently used in mineral sand mining to recover the ore form the mine face as a water slurry by suction. The dredge houses a powerful pump and is floated on pontoons in the dredge pond. In a suction cutter dredge, ore recovery is assisted by a revolving open basket (cutter) mounted over the suction inlet. In hard ground, the cutter can be replaced by a rotating underwater bucketwheel. This term can also be applied to a placer deposit- an alluvial deposit of an economically important mineral or material, usually as a mineral gravel or sand, typically containing gold or gemstones; also a high-grade concentration of heavy mineral sands formed as lenses on present or ancient bench berms by wave action.

Dragline – an excavating machine that uses a bucket operated and suspended by cables and a boom. The bucket is dragged back toward the machine along the surface and usually operates from the highwall or above the area in which soil or spoil is being removed.

Panning – to wash gravel, sand or crushed rock samples in order to isolate gold or other valuable metals by their higher density.

Sluice Box – an elongate wooden or metal trough with riffles, over which alluvial gravel is washed to recover gold.

Hydraulic Mining or Hydraulicking – a form of mining that uses high-pressure jets of water to dislodge rock material or move sediment. In the placer mining of gold or tin, the resulting water-sediment slurry is directed through sluice boxes to remove the gold.

Questions
Answer the following questions related to surface mining.

1) Describe the workings of a surface mine. Please describe how surface mines were worked historically (i.e. panning) versus how surface mines are worked today (i.e. size of dump trucks).

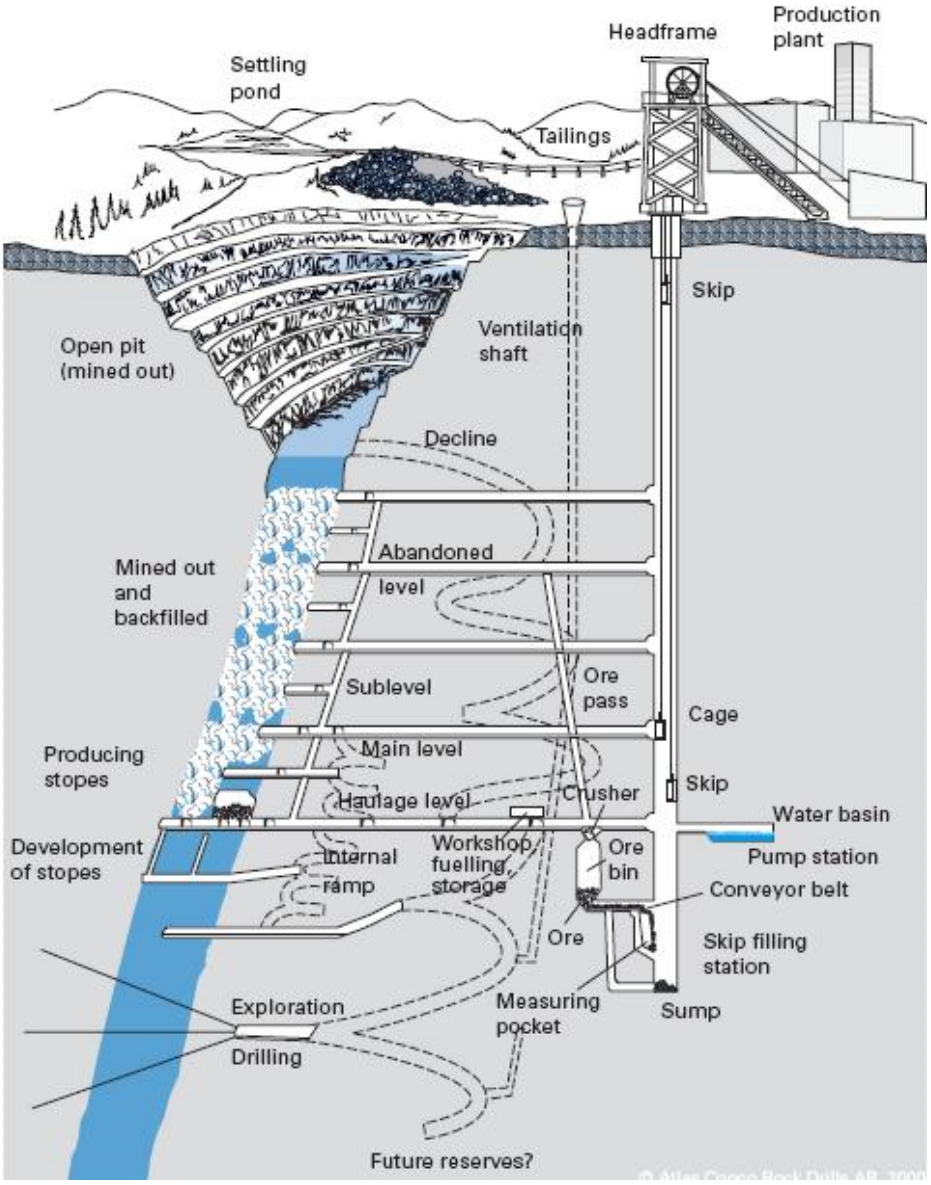
Planning and sluicing – The traditional gold miner's pan is an efficient device for washing and separating placer minerals. Most surface deposits rich enough to be mined and concentrated by panning were worked over long ago, in many cases by Chinese workers left idle after the construction of the transcontinental railroad. In sluicing, the placer gravel is shoveled into the head of an elongated sluice box, which is inclined and has various configurations of bars and traps across the bottom called riffles. Water is directed through the sluice box, and the heavy placer minerals are trapped in the riffles; the fine material is washed over them and out as a relatively barren tailing. In both panning and sluicing operations, it is sometimes possible to collect very fine particles of gold by amalgamation, when mercury is either placed in the bottom of the riffles or smeared on copper plating. The fine gold amalgamates with the mercury and is collected by retorting in small devices, which drive off the mercury as vapor, retaining the gold.

Hydraulic mining – In hydraulic mining, or "hydraulicking," a stream of water under great pressure is directed against the base of the placer gravel bank using pipes and large nozzles called giants. The water caves the bank, disintegrates the gravel, and washes the broken material to and through sluice boxes situated in convenient positions downslope. Hydraulic mining totally disturbs large surface areas, puts much loose debris into the drainage system, and involves large surface water runoff that may cause substantial damage downstream. Many of the western States passed laws years ago to closely control "hydraulicking," and few substantial deposits of placer gravel remain that could be mined economically within the restraints of this legislation.

Dredging – Large alluvial deposits are mined by floating washing plants capable of excavating the gravel, processing it in the washing plant, and stacking the tailings away from the dredge pond. Two kinds of equipment—bucket line and dragline—have been used. The bucket line dredges are larger and more efficient, consisting of a continuous line of buckets that scoop the material from the gravel bank at the edge of the dredge pond, raising it to the top of the washing plant mounted in the hull. Dragline dredges are smaller and less efficient, and employ a single bucket that digs the gravel and is swung over the feeder hopper of a floating washing plant similar to the layout in a bucket line dredge, although usually smaller. Dredging temporarily involves total disturbance of the ground surface, although with careful planning and engineering of the operation, it is possible to plan for restoration of the surface, and perhaps even to improve some aspects of the flood plain or nearby river channel. It is not possible to restore the land to the precise original contour, for the swell factor of the gravel increases volume 20 percent or more. In many areas in the West, particularly near major construction projects or cities, clean gravel placer tailings are valuable for manufacture of

aggregate, or crusher run, in fills of various kinds, and can be considered a resource in their own right. In a few areas, people traveling through areas of old placer tailings, expecting the area to be some sort of wasteland, are pleased to find a great variety of fishing and water sport recreation available, and thriving wildlife in the habitat that has been created. Because large placer deposits can be thoroughly explored before floating the dredge, such operations lend themselves to thorough planning, and it is possible to do a considerable amount of reclamation at only slight increase in overall operating costs.

Modern open pit mining – The students should show a picture like the one below and describe the basic mining process and types of equipment used including very large dump trucks and front end loaders.



I like this figure for both the surface mining and underground mining groups. It shows all the aspects of a mine site, and both types of mining (surface and underground) can go together.

2) What type of geological deposit is mined by surface mining?
In the United States Mining Law of 1872, Congress drew a distinction between the traditional gold placer composed of alluvial material along streambeds, and the vein or lode found in solid rock. In many modern cases the choice is difficult, as many deposits do not clearly fall into either category. Placer claims are staked on all forms of deposit, excepting veins of quartz, or other rock in place. Placers are superficial deposits washed down from a vein or lode occupying the beds of ancient rivers, or deposits of valuable minerals found in particles of alluvium in beds of active streams.

3) Where are abandoned and current surface mines located in Park County?
Placers on the South Platte River and from Tarryall Creek and Beaver Creek Placers that drain the south and east slopes of Mt. Silverheels. Figure 9 of the Colorado Geological Survey publication, Geology and Mineral Resources of Park County, Colorado, shows the geologic setting of the Fairplay gold placer. The most prolific placers were Fairplay, Alma, and Snowstorm Placers in the South Platte River Valley. Other notable placers include Beaver Creek, Carey, and Miller-Sheldon placers on Beaver Creek, and the Peabody-Fortune, Ironwood, and Deadwood placers on Tarryall Creek.

4) How do surface mines use water in the mining process?
Water is used in many surface mining processes to separate out the heavy precious mineral and light gravel or overburden, gravity separation. Water is also used to spray on roads of large open pits to control dust. Like all other industries, mining corporations need water to make bare rock give up its valuable minerals. Mining water use is water for the extraction of minerals that may be in the form of such solids as coal, iron, sand, and gravel; such liquids as crude petroleum; and such gases as natural gas. The category includes quarrying, milling (crushing, screening, washing, and flotation of mined materials), re-injecting extracted water for secondary oil recovery, and other operations associated with mining activities.

5) What are the environmental impacts caused by surface mining?
Large scale mining operations produce a significant amount of waste including *overburden*- the soil and rock that must be removed to gain access to a mineral resource, and *waste rock* – rock that does not contain enough mineral to be of economic interest. In addition to the production of significant volumes of waste, mining can affect the ecosystem and biodiversity of the area. Surface mining often results in total clearance of vegetation and topsoil, often leading to accelerated desertification. Generally the greatest risks to biodiversity are when mining ventures enter relatively remote and undisturbed areas. The very act of building access roads for exploration brings significant risks to biodiversity. Large mining operations use a significant amount of energy (4-7% of the global energy demand). Mining can damage soils including salination, acidification, pollution and compaction. Dust or noise nuisance, gaseous emissions from mine openings such as methane, damage to heritage sites, and destruction of habitats adjacent to the mine site arising from the development of camps, towns and services simulated by the mining project are additional environmental impacts caused by mining. Historic hydraulic mining caused significant environmental impacts including sedimentation and erosion.

6) What are the water quality impacts caused by surface mining?
Although acid drainage is rarely a concern in placer mining, other drainage quality concerns can develop, such as sedimentation and mercury amalgamation. Without proper sediment mitigation features, nearby water bodies can be greatly impacted by sedimentation, which increases turbidity in the receiving water body. Many large open pit and surface mines must pump water from the subsurface (groundwater) to keep the pit dry and stable. The mining company must then dispose of this pumped

water. This can be done by re-injecting it into the subsurface at some distance away from the mine site. Alternatively, the company may infiltrate the water in infiltration basins. These shallow infiltration basins can have significant evaporation, causing concentration of any minerals in the water and creating salt issues. Mining typically increases the amount of oxygen in disturbed soils and rock as well as increasing water mobility. By increasing the surface area of rocks as well as the pore volume around rocks, mining activity allows acid-producing reactions to occur more quickly.

There are four major types of potential impacts from mining and metallurgical processing on water quality including 1) acid drainage, 2) metal leaching and resultant contamination, 3) release of processing chemicals and 4) increased erosion and sedimentation.

7) When were gold placer deposits formed and how? (BONUS)
Placer gold deposits are hosted by glacial moraines and outwash aprons of Pleistocene age and in alluvium of present day. The source of the placer gold in the South Platter River Valley and east-draining tributaries was probably the northeast-trending mineralized belt in the Mosquito Range. The source of gold for placers in the Upper Tarryall Creek drainage basin was probably the Montgomery-Deadwood mineralized area in northwest Park County. The greatest production came from the outer portion of distal terminal moraines and the proximal portions of outwash aprons associated with the maximum advance of Wisconsin stage glaciation in South Platte Valle (Figure 9, Colorado Geological Survey publication).