Wyoming Bioremediation

The program opens with vintage black and white photos and/or file footage of old oil wells and refineries in the western US. The narrator begins.

Narrator: The oil boom that swept across the west early in the 20th century provided fuel for our growing nation and helped shape the character of the American West. For the thousands of enterprising drillers and speculators that rushed to the oil fields, fortunes were often made and lost in a matter of days.

Unfortunately, this boom and bust cycle has left a legacy of abandoned wells and refineries in the region. Contaminated soils at many of these sites are now being cleaned up to protect watersheds and other environmentally sensitive areas.

Long shots of tractors traversing and close ups of plow blades cutting through the soil are seen against the Wyoming landscape as the narrator continues.

Narrator: Of the treatment methods currently available, a team in northern Wyoming is leaning toward an on site process that utilizes natural occurring microorganisms to break down toxins to a level that poses no threat to the environment.

The title screen "Bioremediation" appears over more shots of tractors working. Then, an animated graphic of how Bioremediation works begins as the narrator continues.

> **Narrator:** Bioremediation is the process of taking contaminated soils, adding required nutrients, and irrigating and aerating the soils to enhance the growth of naturally occurring soil microorganisms which utilize petroleum contaminates as a source of energy. In the process, oily wastes are converted to non-toxic end products.

Johanna Miller, an EPA On Scene Coordinator is titled as she gives some background information on Bioremediation. More shots of the landfarm as well as the community of Lovell, WY and the surrounding landscape are also screened as Johanna and the narrator describe the site.

> **Johanna:** Bioremediation, through landfarming of petroleum contaminated soils is not a new technique. It's used quite a bit by the oil industry, particularly, in the basin here in Wyoming. What's innovative about what we're trying is the fact that we're doing it at such a large scale. The 25-acre farm that we have set up here is probably bigger than anything that anyone in this area has done.

Narrator: The site, a former oil refinery abandoned in the 1950's, lies just outside the town of Lovell Wyoming, a small farming community situated at the foot of the Bighorn Mountains and Bighorn Canyon National Recreation Area.

Johanna: The reason the state requested EPA's assistance at this site is that there was an obvious continuing release of oil from the unlined wastepits into Sage Creek. Sage Creek flows into the Shoshone River which is a major waterway in Wyoming and ultimately flows into the Big Horn Reservoir, which is part of a National Recreation Area.

Jim Brown, a soil chemist with Weston REAC, is introduced. Jim and the narrator describes the contamination at the site as we see shots of the petroleum contaminated soils and the treatment cells.

Jim: The waste material that we're treating is a combination of lagoon sludge and contaminated soil that's been in these lagoons for several decades. The technical challenges associated with these refineries are these oily wastes are highly weathered, they are very resistant to decomposition, the organics are very complex, they're difficult for the microorganisms to degrade, so - our challenge is to try to do what we can to accelerate the process and

make it more effective. Decreasing the time where we can meet an acceptable cleanup standard.

Narrator: Over 50,000 yards of contaminated soils were excavated from 6 lagoons and stockpiled at the center of the site.
The site was prepared for treatment by dividing it into four bermed treatment cells to reduce to potential for runoff of surface water. Once the treatment cells were in place, layers of contaminated soil and bulking agents were uniformly applied.

Jim Brown returns to describe how the materials are combined as we see shots of the farm equipment mixing the layers. An animated graphic also reinforces how the layers of materials are stacked in the cells as Jim and the narrator continue to describe the process.

(animation in bold) Jim: Well, the first thing that we are doing out here is applying what we refer to as an initial layer, or a lift of organic bulking agents to loosen these contaminated soils which are very high in clay and very difficult to manage. **We're using an initial lift of 4 inches of that material followed by 8 inches of contaminated soil**. We're going to completely till that material with a series of agricultural implements in order to loosen It, to reduce clogs, to make it much more treatable. **After we've got that first lift in good physical condition, we'll repeat the same process again so the total thickness of material we'll have to treat will be 24 inches, which is quite thick.**

Narrator: The key to making the process efficient is to actively mix the contaminated soil and bulking agents. The mixture must remain moist and contain the necessary nutrients, particularly nitrogen, to degrade the petroleum hydrocarbons. Effective treatment requires that soils which are very high in clay become loose and friable, providing both oxygen and nutrients to petroleum degrading microorganisms. To this end, special tillage equipment was designed to penetrate to a depth of 24 inches.

Jim: We are using, or going to be using, some modified agricultural equipment that can till material that thick because conventional machinery usually doesn't operate to that working depth.

Images of the harsh Wyoming landscape are seen as the narrator and Royal Nadeau, Associate Center Director for EPA's Environmental Response Team explain the local climate and it's affect on the remediation.

Narrator: The other key ingredient in the microbial stew is water, which happens to be in short supply in the basin country of northern Wyoming. The dry, high desert landscape receives an annual rainfall of only 3 to 5 inches.

Royal: For this particular site what makes it so unique is the fact that we're working in very severe climate in regards to the microbes. The microbes like moist, warm, environment. So that's why we really have to add a lot of water to the soil to bring the moisture levels up to where the microbes will actually work the best for degrading these compounds.

Shots of the sites irrigation system working are seen as the narrator, Johanna Miller, and Jim Brown detail the need for water at the site.

Narrator: Water to irrigate the site was pumped from Sage Creek, actually the same stream at risk of contamination. A portable irrigation system was then rigged to deliver water to the treatment cells. The soil water content was maintained within an optimum range of between 18 and 22% of the soils dry weight.

Johanna: We're going to be watering and tilling the soils every week for a period of 5 or 6 months while the temperatures are warm. At that time we will evaluate our hydrocarbon degradation and hopefully we'll be at a point where we've reduced the concentrations to a safe level.

Jim: We're anticipating right now, two full operating seasons of '97 and '98 to effectively treat these soils to an acceptable cleanup

level that has been determined by the State of Wyoming to be acceptable.

Long shots and close up shots of the tractors working the land are seen as the narrator introduces the "testing" portion of the program.

Narrator: With the exception of the customized tilling equipment, most of the techniques and resources used on the site were considered standard for petroleum bioremediation. Locally available bulking agents such as sawdust, wood chips and composted cattle manure were used to improve the soil's physical properties and provide required nutrients.

Additionally, as part of ERT's interest in evaluating innovative methods of bioremediation, new products developed to treat oil spills were tested. If a product is found to be successful, it may be used over the entire site during the final year of treatment.

Royal Nadeau and Jim Brown return to describe the plans to test "innovative" Bioremediation techniques at the site.

Royal: One of the unique aspects of this project is that we are utilizing some of the commercially available products that have been developed for treating oil spills. Since the Exxon Valdez, the agency has put a lot of energy and money into research for

cleaning up oil spills using, you know, microbial populations and various amendments that are added to the oil or the contaminated soil.

Jim: Well, what we're going to do is compare conventional treatment to some innovative treatments**.** We did some prescreening of products that could enhance or accelerate the Bioremediation process. We selected on what was the best performer, which is an oleophilic fertilizing material which is attracted to oily surfaces. We don't have a lot of information on their effectiveness in contaminated soils, but that is part of the reason that we are doing that at this facility. To see if we can accelerate the Bioremediation process and make it more cost-effective.

Shots of the team setting up the test cells and taking samples are seen as the narrator and Jim Brown describe the process.

Narrator: Nine 12 by 12 meter test plots were staked and laid out. The “innovative” materials were then integrated into the soil using a four wheel drive tractor, allowing maximum traction with minimum soil compaction. To guarantee improved aeration, a specially modified ripper blade was machined that could extend into the soil mixture a full two feet.

Narrator: A custom sampling regimen was developed that identified the optimum number of samples needed to determine any statistical difference between the test and untreated control cells. A total of thirty-nine samples were taken each month to monitor the effectiveness of different treatments.

Jim: We will be reassessing our data of course. Every month we will take a look at it, and we will be projecting how long it will take to successfully treat the soils at the entire site.

Narrator: The hope is that one of the innovative treatments is effective enough to be adopted for use at the site the following year and possibly at other petroleum contaminated sites.

Jim: We're looking at this as a model for other old refinery sites out here in Region VI and Region VIII. Out west here and in the southwest there are a lot of these old abandoned refineries with large volumes of contaminated soil that are going to require cleanup, and we're hoping that this can be a model to clean up some of those other sites as well.

Shots from the testing as well as conventional Biorenediation are seen as the narrator, Royal Nadaeu, and Johanna Miller give their final assessments of the site and the treatment method.

Narrator: Bioremediation is an on-site treatment method that doesn't require off site transportation of contaminated materials. It is also more cost effective than other treatment methods, making it more appealing to taxpayers.

Royal: The cost benefits for this technology are fantastic compared to some of the other technologies that have been used before for taking care of these compounds. You know, even though it takes a little bit longer, the costs may be 5 or 6 times less than what it would take to use incineration or soils washing or one of those very energy intensive technologies.

Narrator: The work at the Lovell Refinery site has proven that longer term, low impact treatments like Bioremediation can be accepted by the community and be effective.

Johanna: All in all this has been an incredibly successful project**.** This is our third year of operation and there's just been an incredible transformation in this site. Everyone who comes and visits is surprised at what we have been able to do in terms of

taking 25-acre industrial area that was basically destroyed and filled with this residual waste oil and turn it into something that's environmentally benign.