

BP Refinery Site, Casper, Wyoming, USA

Three Crowns Golf Course

By: Larry Peters

The Three Crowns Golf Club resides at the Platte River Commons, formerly known as the Amoco refinery and was first operated by Midwest Refining Company in 1913, to process petroleum from the Salt Creek Field, located about forty-five miles north of Casper, Wyoming.

In 1923, the Salt Creek Field peaked at 100,000 barrels per day. Standard Oil of Indiana took controlling interest and invested \$10 million to expand it. In 1941, refining was modified to supply the military with fuel oil, toluene for explosives and aviation fuel, and in 1953, the refinery began making commercial aviation fuel and increased the octane of motor gasoline.

Standard Oil's refinery was said to be the largest plant in the world for volume of gasoline produced (*614,000 gallons per month*). At the height of production, 48,000 barrels of oil were processed, and the refinery employed approximately 750 people. In 1973, Standard Oil Refinery changed its name to Amoco Refinery.

The former Amoco Refinery, located on the western side of Casper, was the lifeblood of the community's economy for over 60 years, since its beginnings in the early 1900's. It provided thousands of well-paying jobs and refined petroleum products to Casper and the nation. Amoco employees participated in local affairs and were a vibrant, active part of the local citizenry. However, consistent with practices in the early days, waste generated at the refinery was either buried or allowed to discharge directly into the North Platte River or into the groundwater below.

The refinery process area occupied approximately 340 acres, which was supported by a tank farm, to the north, of approximately 700 acres. Beginning in 1981, prior to the time of the refinery shutdown, Amoco began to implement a plan to clean up the site and prevent the underground flow of contamination. It did so by installing several groundwater recovery wells and accompanying pumps. 120 recovery wells have been installed within the golf course and along the barrier wall. These wells pump groundwater out at a rate of 700 gallons per minute. The oil and other chemicals are then separated through a series of filtering wetlands, which serve as water hazards on the golf course.



The primary goal during demolition cycle was stated as “No Harm to People, No Harm to Animals, and No Harm to the Environment”.

A wide variety of ZenEarth products have been used on site as a component of complete remediation, restoration and on-going maintenance.

INSECT SPRAYING

The Wyoming region has long been known for its mosquito and black widow spider community, and use of ZenEarth mosquito pesticide provided an added degree of safety to all contractors and employees on site. The “insecticide” is bio-based and biodegradable.

During the initial years of club construction several applications were made throughout the year and increased in frequency during the grand opening of the golf course. Given the success of applications in removing these harmful pests from areas which had been sprayed, a larger territory has been included in subsequent years, including areas that had been off limits during previous summers. Both banks of the North Platte River, the front nine golf course irrigation ponds, and any other area deemed important are now included in the application program. ZenEarth products are now used exclusively for all pest control.

ZenEarth is an excellent companion for use in areas with sensitive environmental and habitable considerations such as those near the golf course.

The county fairgrounds complex is immediately adjacent to and upwind of the site with a heavy, year around population of farm & ranch animals.

Immediately across the street to the south of the entire property border is an older established neighborhood with irrigated lawns, gardens, bushes & trees that are all prime habitat for mosquitoes.

The front nine of the golf course contains 3 large bodies of water that are water hazards for the golf course as well as the source of irrigation water storage.

The back nine of the golf course contains a series of 9 interlinked ponds that are water hazards for the golf course, but are also the bioremediation ponds for the treatment of groundwater from all of the recovery wells.

The North Platte River borders the entire north side of the property for a distance of approximately 1 and ½ miles, complete with an overgrowth of mosquito habitat vegetation.

OIL DEGRADATION

Despite the use of a pump and filter remediation process, some of the water hazards continue to exhibit pockets of oil sheen.

A specially formulated ZenEarth colloidal solution has been successfully utilized on site to accelerate decomposition and remediation of these hydrocarbon contaminated areas. The formulation is able to bio-degrade hydrocarbons so that within 28 days, >95% of all hydrocarbons have degraded to become benign.

BASIC REMEDIATION PROCESS

There are approximately 50 active oil recovery wells placed in strategic locations across the site. Some are situated across a major thoroughfare immediately east of the main property. The majority of the oil recovery wells are on the main site, with half of them placed inside the Barrier Wall on the south bank of the river. The other half are scattered across the entire length of the golf course. On-site wells are surface completed and not visible above ground. Along the entire border of the river, a steel interlocking barrier wall has been driven about 40 feet into the ground and terminated in bedrock. This barrier wall prevents oil contamination from migrating off the site, and into the river. The golf course comprises about half of the length of the property on the south and the north half of the site is the “opportunity area” which can be used for future public-access development such as a business park, civic center, etc.

Recovery wells are constructed as shallow water wells which contain refined oil contaminated groundwater. Wells average 35-40 feet in depth. Each well contains two electrical pumps. A submersible water pump is located within a few feet of the bottom of the well. An oil pump is suspended approximately half-way down and just below the water drawdown level.

Water pumps are operated continuously with flow rates adjusted according to location within areas of identified oil plumes, as well as with seasonal changes in the depth of the groundwater. Continuously operated water pumps create a cone of depression within close proximity of the recovery well. Oil floats on the surface of the groundwater and flows down this gradient slope and into the well bore. Automated oil/water sensing probes suspended in the well identify the oil and once a certain depth of oil is accumulated, the oil pump removes the oil and sends it directly to a battery of recovery tanks where it is stored and hauled to a refinery.

The groundwater contains microscopic oil contamination and all of the recovered water is pumped through an oil water separator through a series of sumps & pumps before being transferred to the farthest remediation pond. Water flows downhill with elevation changes through a series of ponds containing biological filters, through a series of wetlands, as well as subsurface wetlands until it finally reaches the last pond. From this final pond, fluid flows into a “finished water” sump where it is

pumped offsite to a landlocked lake that is an officially sanctioned Audubon Bird and Wildlife Sanctuary Area. By the time the finish water leaves the site, it is continually tested and must show a “non-detect” for oil.

RECOMPLETING OIL RECOVERY WELLS WITH CASING CUTTER

An issue with existing remediation processes were that any oil recovered from the process required environmentally acceptable disposal methods which incurred additional costs. Use of the SC-400-1 product has been extensively used to degrade hydrocarbons on-site thereby eliminating costly additional environmental disposal fees.

SC-400-1 is now used for recovery well recompletions to clean scale off the inside of the well casing, clean the casing screens, and clean out the impacted soil surrounding the immediate vicinity of the well bore. This in turn enhances flow rates. Two “traditional” chemical products had been previously to perform this operation. Problems associated with use of these chemicals (LBA and DBA) created demand for a more environmentally sensitive product with better attributes.

Products formerly used were acidic and extremely hazardous.

Additionally, recompleting each well required constant swabbing with the first chemical continuously for a period of 6 hours, followed by introduction of the second chemical and isolation of the well for another 24 hours before airlifting sediments through piping prior to re-starting well operations and reinstalling all of the pumping equipment.

Hydrogen sulfide off-gassing had consistently been an issue at the site and occurred through the use of traditional chemicals. This in turn created unsafe conditions for recompletion crews and complaints of odours from neighborhoods and businesses downwind of the site.

ZenEarth casing cutter was introduced to the remediation process as an alternative to these traditional chemicals.

Approximately 8 ounces of Casing Cutter were introduced to the borehole for each foot of water column. Benefits arising from the use of Casing Cutter included;

1. Recovery of approximately 80% of treated oil.
2. Elimination of all hydrogen sulfide off-gassing. Use of a calibrated gas detector revealed no release of any VOC's (*volatile organic compounds*) from the well bore.
3. Dramatically reduced swabbing times. Scale was completely removed from the casing walls within 15 minutes.

In comparison, the conventional treatment system had required 6 hours of continual swabbing with 5 gallons of LBA concentrate, followed by removal of the swab, the addition of another 5 gallons of DBA (*both hazardous products*), reassembly of the swab followed by at least

1 more hour of swabbing to push the second product through the screens and into the impacted soil, and removing/cleaning /separating swab pipe a second time.

One well had historically required a full day to set up, swab, and break down the equipment. A second day would have been required to set up equipment and air lift sediments from the same well. In the traditional form of swabbing a slow release of H₂S gas by-product would have occurred during this entire period.

4. Additional benefits included reduced demobilization time as tools removed from the borehole were clean of all hydrocarbon contaminants thereby accelerating rig break-down and demobilization.

Using ZenEarth Casing Cutter allowed for recompletion of two wells per day.

CASING CUTTER USED TO "TREAT" RECOVERY WELLS

Shown at far left is a stainless steel Grundfos submersible water pump. Iron sediment bacteria cover the apparatus.



Photo at right is the 2 inch discharge end of this same water pump. It is easy to see that the flow of water was seriously restricted.



Dismantled discharge manifold located at the surface above the submersible pump.



Note how the outside of the pump, intake ports on the pump, check valve and discharge line are all either covered or plugged with this buildup of iron sediment bacteria. This pump had been in service for less than one year.

Casing Cutter is now used as preventive maintenance treatment and has eliminated maintenance formerly needed to remove, clean, and reinstall equipment. The maintenance program has enabled a reduction in pump replacement from premature mechanical failure which arose from solids build-up. Quite often, this buildup results in replacing equipment which fails prematurely.

Test of flow rates during Casing Cutter treatment showed no changes and a consistent flow rate stayed at 25.953gpm.

Success of the well treatment program created an immediate demand for Casing Cutter treatment for all 52 wells.

An additional downstream benefit has included an elimination of Oil Water Separator cleaning.

ALGAECIDE

There are 9 bioremediation ponds on the back nine holes at Three Crowns. Ponds vary in size from less than half an acre to approximately 3 acres. Only one of these ponds is more than 4 feet deep. All ponds have rubber liners on the bottom, an accumulation of sands and soil have accumulated at the bottom. The shallow ponds combined with layers of soil, and abundant sunshine during summer months had created algae problems in these ponds. Algae plugs had developed in outlet screens, splitter box structures, and screens on high volume discharge pumps as well.

A Colloidal Algae Concentrate is now used to completely eliminate algae growth. A mixture is sprayed on ponds at a dilution rate of 35:1 (*mixed with pond water*). Three forms of algae occur at these ponds.

- Hair algae clings to every surface
- A rooted algae forms large thick umbrella-like mats on the surface, and;
- Carpet algae

Water flow rates at these ponds range from 700 to 1200gpm.

Formerly, two men required 2-3 hours per day for algae removal.

INDICATOR SPECIES

Water quality degradation is seen most noticeably through plant/animal population decimation. Active pond life is important indicator and an absence of plant and animal life is a suggestion of out-of-balance wetland areas.

Biological filters existing in ponds include a large stand of cattails and bulrushes which were purchased and planted for that specific purpose. Killifish have also been introduced into the ponds as an additional biological control of mosquito larvae.

The introduction of ZenEarth's products into the water system through applications described above has not caused any adverse effect to wild life.

Cattails and bulrushes have grown and spread far beyond the initial planted areas. Frogs are abundant in all ponds.

A large population of ducks and Canadian geese reside in the ponds. The avian population creates a nutrient-rich environment supporting the growth of algae which in turn is regulated using ZenEarth products. A large population of killdeer and avocets nest at water's edge.

Additionally, a large group of mule deer live in wetland areas.

Wild turkeys, golden eagles, bald eagles, pelicans, cormorants and osprey are seen frequently along the river.

The use of ZenEarth products onsite has not degraded the successes of constructed wetlands areas.

OTHER PRODUCT USES

Infrequently, an iron sediment flocculant rises to pond surface and includes light thin streaks of oil that appear within it. SC-400-1 degrades the oil immediately but the flocculent recurs with wind and wave action.

A mixture of SC-400-1 (*degrade oil*) and Casing Cutter in a 50/50 mixture provides an effective solution for this problem. Oil is degraded upon contact and the iron sediment flocculate is degraded and does not reform.

Colloidal spray is also used to clean numerous electronic sump level indicator probes.

Colloidal solutions are also being used to remove grime from tile floors in the control room and the motor control center.

Colloidal solutions remove oil odors from indoor floor drain sumps in close proximity to hard-wired LEL detectors. This prevents facility shutdowns from high LEL sensor readings in closed-building environments due to remnants of sump contents. This is especially important when draining specific equipment results in oil flowing into indoor sumps.

There are other ZenEarth products used onsite including; a hand cleaner kept in the administrative building, a product known as Geese Police that has been successfully used to condition geese to remain away from frequently used areas of the golf course.

CLEANING THE AIR SPARGE SUBSURFACE WETLANDS SYSTEM

Casing Cutter is also being used to remove calcium carbonate scale from the interior of subsurface air sparge lines located underneath subsurface wetland areas. In the past, sparge line cleaning was accomplished with the acidic DBA products formerly used for recompleting recovery wells. To complete subsurface wetland(s) treatment in the past required 32 - 5 gallon containers of DBA, and approximately 8 weeks to complete.

Use of ZenEarth now takes no more than 10 days for subsurface wetlands and uses only a fraction of the amount of Casing Cutter as formerly required with DBA. Use of the products has eliminated the many safety concerns related to use of products such as DBA.

IN CONCLUSION

As noted, a two-week application of insect treatment has resulted in multiple uses on a daily basis with 3 separate ZenEarth products (*SC-400-1*, *Casing Cutter*, and *Colloidal Algaecide Concentrate*). Products are used separately or in many cases are combined to provide a more effective solution or application procedure.

Three Crowns Golf Club url: <http://www.threecrownsclub.com/>

The active ingredients behind all “green” ZenEarth cleaning, solvent and lubricating products are combinations of various readily biodegradable plants and naturally occurring minerals. ZenEarth’s proprietary renewable chemical/mechanical process creates a truly unique product that is safe for human use and for the environment. It is effective and versatile.

All ZenEarth active ingredient formulas are effective as a result of the creation of electrically charged particles known as micelle. When activated in water, micelles repel each other in a ceaseless random movement. Measuring only 2 – 4 nanometers in size, their extreme surface-area-to-volume ratio enables far greater efficacy than conventional technologies or formulas. Micelle do not produce a chemical reaction that generates new compounds when introduced into another material or the environment, instead they break down carbon based molecules into smaller molecules and/or atoms that can be easily assimilated and metabolized by normal soil or water microorganisms.