Lake Shoreline Stabilization & Enhancement Project Elk Mountain Ranch Carbon County, WY

Prepared by

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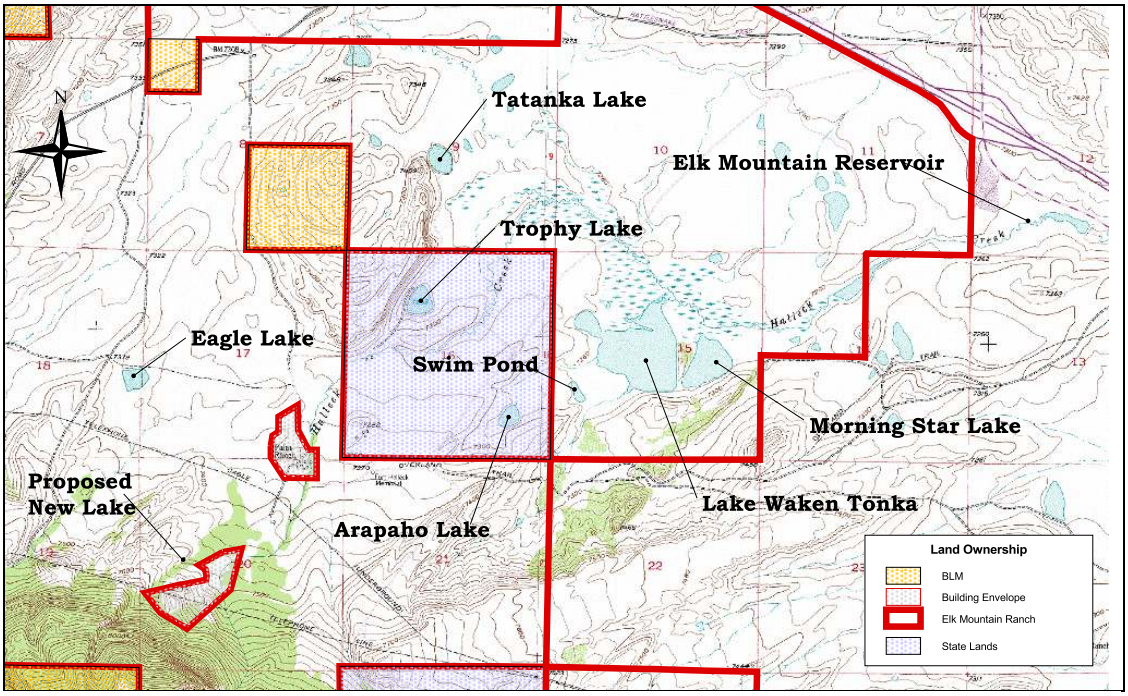
Purpose and Need

There are twenty-five lakes and stock ponds found on the Elk Mountain Ranch. Of these water bodies, seven are managed for uses including recreational fishing. The remaining stock ponds are used exclusively for livestock watering, and frequently completely dry up in late summer and fall. All of the lakes and stock ponds are within the Halleck Creek watershed on the north side of the ranch, at elevations below 7,300 ft. (Map 1)

Freshwater lake, or lentic, habitat is composed of a littoral zone that is euphotic and hence may be heavily populated by aquatic plants. Deep water, or profundal zones, are aphotic, and therefore do not support the photosynthesis necessary for plant development. These profundal habitats create important thermal refugia in the summer months, and may provide for critical over-wintering capacity during severe winter months. The benthos (bottom) of many lakes consists of oxygen-demanding organic detritus and is thus anaerobic. Benthic life such as bacteria and midge larvae, however, thrive and utilize the organics as food.

Over time, lakes change physically and chemically. Aging in lakes involves a progression of changes from deep, nutrient-poor oligotrophic water bodies eventually evolving into shallow, richly organic eutrophic lakes. As lakes become more eutrophic, higher temperature and other



Map 1: Fishing Lakes on the Elk Mountain Ranch, Carbon County, Wyoming

water quality issues begin to affect the lake's capacity to support cold water species such as trout. With greater nutrient loads and temperature, undesirable aquatic plants, such as algae, floating and submerged weeds may become established. Proliferation of aquatic vegetation can lead to loss of suitable habitat for forage species and juvenile trout, higher pH, and temporal crashes of critical dissolved oxygen in the water as dead plants decay and consume the available oxygen in the system.

Photo 1: Southeast shoreline of Arapaho Lake..

The seven "fishing" lakes on the Elk Mountain Ranch range from 1 to over 90 surface acres. The lakes capable of supporting fisheries are Lake Waken Tonka, Morning Star Lake, Arapaho Lake, Trophy Lake, Tatanka Lake, Eagle Lake, and the Swim Pond. The lakes are fed by diversion ditches from Halleck Creek and it's tributaries, or by underground springs. The lakes are surrounded, for the most part, by relatively dry prairie with no woody vegetation to provide solar shading in the summer months. All of the lakes exhibit some level of shoreline erosion due to wind and wave action along the leeward shores. In many instances, this shoreline erosion is further filling in important lake habitat and should be stabilized. All of the lakes, with the exception of the recently constructed Swim Pond, exhibit characteristics consistent with older, shallower eutrophic lentic systems, with limited profundal zones, significant aquatic vegetation, and relatively high temperatures.

Five of the lakes were excavator dredged in 2003, creating deep water trenches and islands along the edges of the water bodies. The spoils from the dredging apparently were not re-seeded, and this material is gradually eroding back into the lakes (Photo 2). Additionally, these disturbed areas have created opportunities for noxious weeds such as Canada thistle to become well established along the shorelines of most of these lakes.

Photo 2: Spoils Pile and Eroding Bank at Eagle Lake.

There is a severe noxious aquatic weed infestation in all of the "fishing" lakes on the Elk Mountain Ranch. These weeds have reduced available habitat for existing fish in these ponds, have altered the water quality, and may result in significant fish-kills from lack of oxygen in several of the lakes as the vegetation dies off in the fall and begins to decay in the bottom of these lakes. The weed infestation is severe in all of the lakes except Swim Pond and Morning Star. Of particular concern is the presence of Eurasian Watermilfoil in Trophy Lake. This weed is a particularly aggressive species that is very difficult to control. Once established, Eurasian Watermilfoil may be difficult to eradicate, and can easily spread to other water bodies.

Project Methods

Shoreline Stabilization:
All of the lakes exhibit some level of shoreline erosion due to wind and wave action along the leeward shores. In many instances, this shoreline erosion is further filling in important lake habitat and needs to be stabilized (Photo 3). Additionally, many of the islands constructed during the 2003 dredging effort are extremely unstable, and continue to erode back into the lakes. A site survey in early May 2007, was conducted to identify and measure the length of shorelines requiring treatment.


Photo 3: The actively eroding southern shoreline of Waken Tanka Lake.

Root-wad revetments and log toe-slope stabilization techniques are useful for hardening of the shoreline to protect from erosive wave action. These areas may be treated using large wood to create a stable toe and full-pool bench on the bank, then the upper portion of the bank may sloped back and revegetated (Photo #4)(Drawings 10 & 11 - Appendix). The full pool bench should be revegetated using locally available willow and sedge mats harvested from areas nearby the site. Root-wads and trees can be obtained locally from harvest areas planned on the ranch. Mats of carex, rushes, sedge and willow will be selectively harvested from adjacent riparian areas and transplanted behind and on top of the root-wad revetments to create a natural looking and well armored shoreline. Estimated fill below the full pool watermark for this treatment is estimated to be less than 0.1 cubic yard / linear foot of lake shoreline. We propose to complete all of the shoreline stabilization and enhancement during the fall of 2007.


Photo 4: Log toe-slope stabilization of a stream

Inlet and Outlet Improvements:
Water depletion and evaporative loss are a significant limiting factor to several of the fishing lakes on the ranch. While most of the lakes exhibit an acceptable ratio of deep/shallow habitat at full-pool, all are habitat limited at the water levels observed during the August 2006 assessment (LSA, 2006). Trophy Lake and Swim Pond may benefit from additional water exchange through inlet and outlet enhancement. Improved flow into these lakes should improve overall water quality and reduce daytime temperatures. The capability of diverting water into Trophy Lake can be enhanced by installing a cross-vane at the diversion point on Halleck Creek and replacing the head-gate and cleaning the vegetation out of the inlet ditch.

Flow into the Swim Pond is limited by the existing over-wide channel between Arapaho Lake and the pond. Additionally, water can only be moved into Swim Pond when Arapaho Lake is at full pool stage. We propose to install a head-gate and construct a new E channel between the two lakes to allow for water movement and fish passage even during late summer months. This work can be completed during the fall of 2007. Details of these enhancements are described in the specific lake treatments section of this document.

Photo 5: Typical 16" head-gate and culvert assembly, with a cross-vane immediately downstream. Cucharas River, Colorado..

Dredging and Weed Control:
Several of the lakes appear to be nearing the end of their useful life as cold water fisheries. Lake Waken Tanka, has likely already past this point, and may best be managed for waterfowl nesting, amphibian and native minnow habitat. Dredging may extend the useful life of several of the lakes, as well as helping to control the aquatic weed infestations that are currently present. Mechanical removal is a preferred method of removing submerged weeds, since is does not require the application of herbicides and other potentially hazardous chemicals to the lentic environment, and poses the least risk to resident aquatic life.

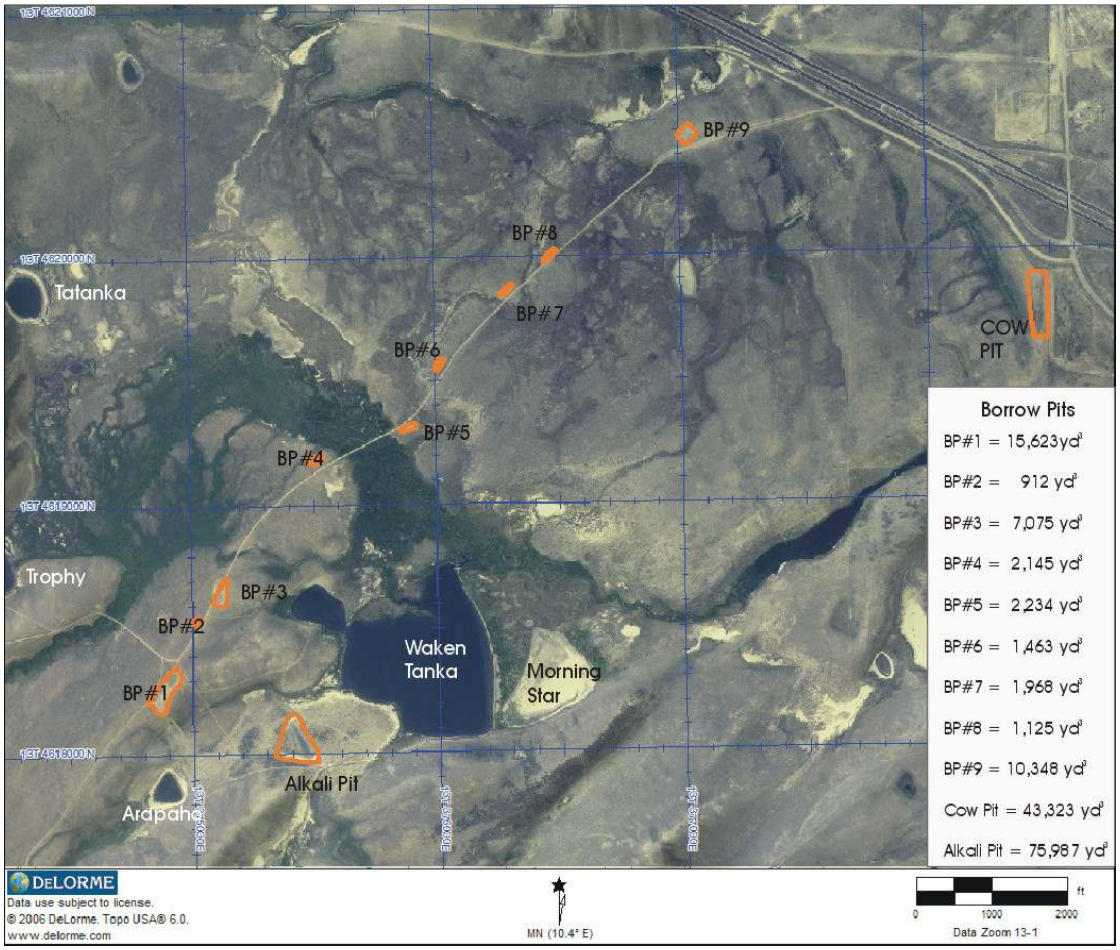
The Natural Resource Management Plan (LSA, 2006) developed for the ranch recommends draining and excavating Eagle, Arapaho, Tatanka and Trophy Lakes. Dredging efforts should focus on removal of the seed bed along the shallower littoral zones to reduce the aquatic weed density in these areas, and creating contiguous profundal zones of at least 8 -12 foot depth near the center of the lakes instead of along trenches near the shoreline. We recommend that dredging efforts be conducted using methods considered "non-jurisdictional" by the US Army Corps of Engineers (USACE). This will require draining the lake, and ensuring that all disturbed materials below the ordinary high water mark of the lake be completely removed and stored on adjacent uplands in a manor consistent with the Ranch conservation easement.

Photo 6: Lake Excavation using a large excavator and 6 wheel articulated dump truck. Manitou Lake, Teller County, CO.

To successfully accomplish dredging of the lakes, it is recommended that flow into the water body be terminated by mid-summer, allowing for evaporative loss to reduce the level of the lake to 1/2 full pool or less by the late fall. In late October, the remaining water in each lake to be treated will be pumped out, using a 5 cfs capacity floating pump. This size pump is capable of draining approximately 10 acre/feet per day. Each lake to be treated will take between two to four days to drain, depending on water surface level and degree of weed infestation. During the pumping process, fish salvage will be conducted, using seines to capture fish remaining in the dead pool at the bottom of the lake. These fish will be transferred to an adjacent lake using a truck mounted stock tank and oxygen aeration system.

Once the lake to be treated is drained, it will be allowed to dry out and freeze over the next two to three month period. Excavation of the lake bottom will completed during late January, February and early March, using a large excavator with an 8ft. bucket. All disturbed spoils will be transferred directly into 18-20 yd^3 six-wheeled articulated dump trucks or similar pieces of equipment (Photo 6), and hauled to designated storage sites on the property. It is anticipated that two or three of these vehicles will be operating continuously during the project.

Ten storage sites were identified during the May 2007 planning assessment for the project (Map 2). These sites consist of old gravel borrow pits immediately adjacent to the road accessing Ranch Headquarters. The borrow pits are, for the most part, barren of vegetation, and were never rehabilitated after the construction of the road. The pits range in size from 0.2 to 5 acres, and are capable of containing approximately 86,000 yd^3 of lake spoils. These pits will be filled with spoils from the lake excavation. After dredging activities are complete, the filled pits will be graded to the same level as the surrounding landscape, and reseeded using native seed. Additionally, sediment fencing may be used if necessary to ensure that no spoils erode from the storage sites back into any perennial waters before vegetation becomes established on the rehabilitated pits.
In addition to the ten borrow pits previously described; there is an abandoned pond/alkali flat south west of Lake Waken Tanka that may be another potential storage area for lake sediments. This feature is approximately 5 acres, and has the capacity to store another 76,000 yd^3 of material. Current estimates of the volume of lake sediment to be removed from the four lakes indicates that the borrow pits may be adequate to store these spoils. It is not anticipated that this feature will need to be used unless all of the borrow pits are filled.



Map 2: Borrow Pit Lake Sediment Storage Sites, Elk Mountain Ranch, WY.

After each lake has been excavated, a few large trees may be anchored in the deeper areas, using Manta-Ray or similar dead-man anchors to prevent the trees from floating to the surface (Photo 7). These trees will add important habitat complexity and cover for smaller juvenile fishes and forage organisms. A few boulder clusters may also be considered if boulders are remaining from the shoreline stabilization work.

Dredging operations should be completed by the middle of March, and re-filling of the lakes can begin with the spring snowmelt and associated run-off. Trout stocking should be scheduled for late June, after the lakes are 1/2 full, with hatchery scheduling and state stocking permits being applied for in the fall preceding the dredging work. Aquatic insect populations may require some time to recover after filling, and the ranch may want to consider supplemental feeding of stocked fish for the first season after dredging is complete. If desired, we can install automatic, solar powered feeders that can dispense a measured amount of feed at specific intervals.

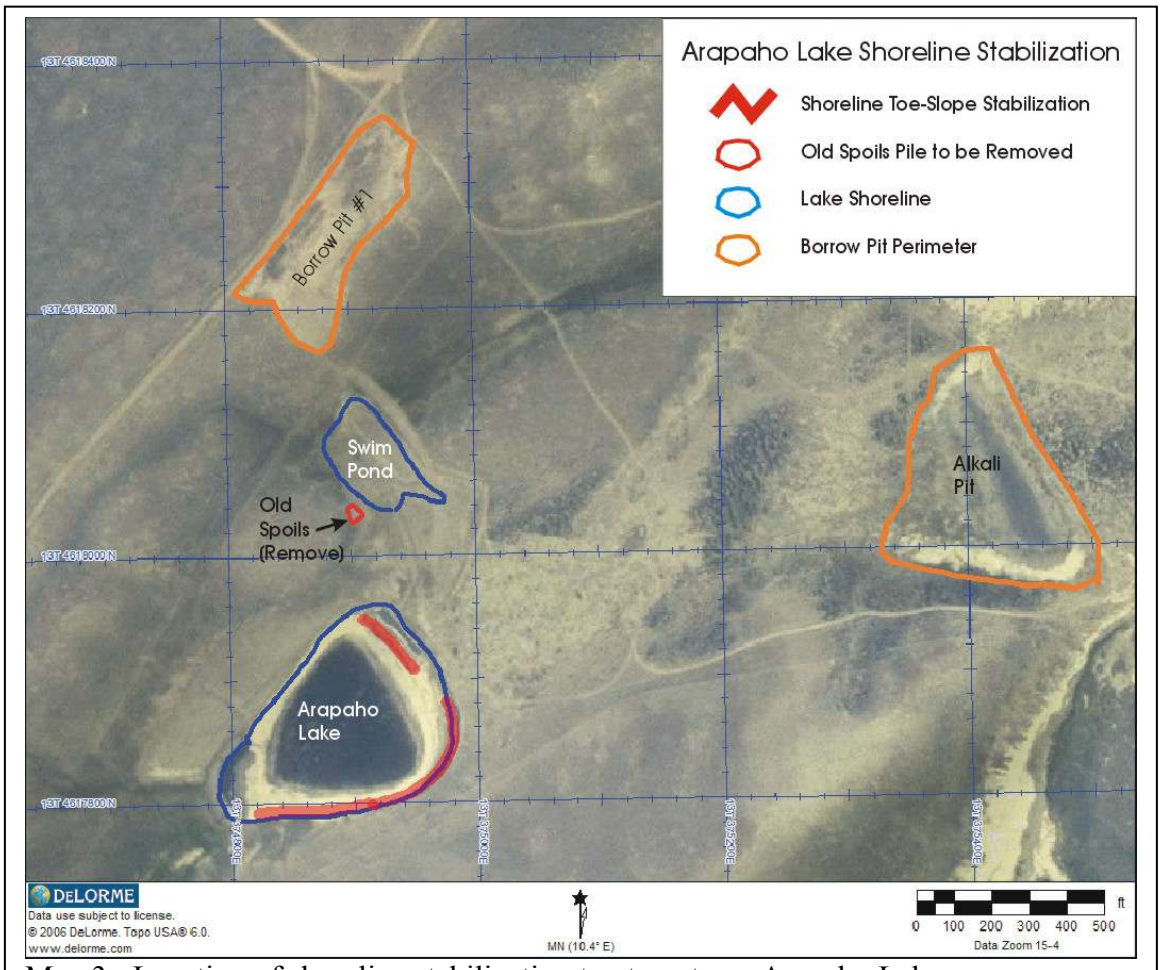
Photo 7: Trout Unlimited volunteers anchor a large pine in the lake bottom using a 90lb pneumatic drill and stainless steel Manta-Ray MR-1 anchors. Manitou Lake, Teller County, CO.

It is anticipated that two lakes can be done each season using the methodology described above. We propose to complete Arapaho Lake and Trophy Lake during winter of 2007-2008, and Tatanka and Eagle Lake during winter of 2008-2009.

Project Description

ARAPAHO LAKE

Shoreline Stabilization:
Arapaho Lake exhibits severe erosion along its southeast shoreline and along the island constructed on the north side of the lake. Approximately 700 feet of the lake shoreline on the southeast and south side will need to be treated using the log toe slope stabilization techniques described in the preceding section (Map 3). Additionally, the barren upland slope above the eroding shoreline on the southeast side of the lake will require stabilization and re-vegetation using either geo-textile or coconut jute fabric.



Map 3: Location of shoreline stabilization treatments on Arapaho Lake.

The island on the north side of the lake may also be treated using root wad revetments and log toe slope treatments. Approximately 150 feet of shoreline will be treated along the island. In addition to shoreline stabilization, the elevation of the island will be lowered approximately one foot, in order to reduce the bank slope and allow vegetation to take

hold. Excavated material from the island, and the old dredging spoils pile next to the Swim Pond, will be hauled to Borrow Pit #1.

Approximately 30 trees will be needed for the Arapaho Lake shoreline stabilization work. Sedge mats may be harvested from the riparian area downstream of the Swim Pond. Additional coyote or bar willow may need to be purchased from a nursery and planted along the restored shorelines. Bare-root stock willow planting should be done in the early spring, just before the plants begin to emerge from dormancy.

New Outlet Channel:
The existing outflow channel from Arapaho Lake to the Swim Pond can only function in the spring, when Arapaho Lake is at full pool level. The existing channel is 318 ft long and relatively straight, and averages approximately 18-25 feet in width. The slope of the existing channel is approximately 1% (Diagram 1). The outlet is uncontrolled, and the

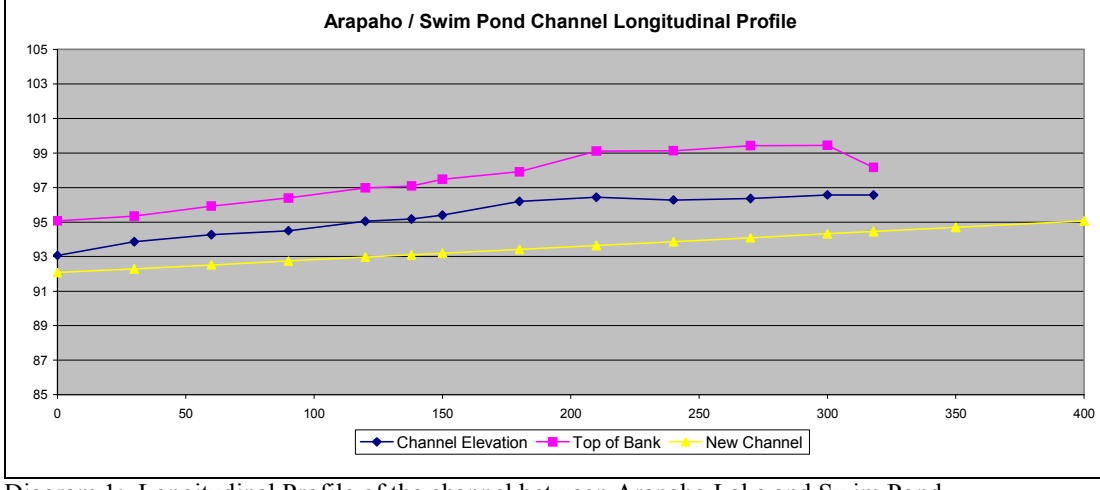


Diagram 1: Longitudinal Profile of the channel between Arapaho Lake and Swim Pond.

channel is over-wide and shallow, creating a barrier to migration of fish between the two impoundments. Poor water exchange may be the most limiting factor creating water quality problems in the Swim Pond. Constructing a new outlet structure and Rosgen "E" channel connecting the two lakes will allow water may be transferred from Arapaho to the Swim Pond at critical times during the late summer and fall, when water quality problems are the greatest threat.

A 16" head-gate and twenty foot long culvert will be installed at the outlet of Arapaho Lake, at an elevation two feet lower than the lowest point of the existing channel. The old channel will be back-filled to a level 1 foot below the existing grade of the surrounding landscape, to allow for overflow in the event of a flood, and the shoreline will be armored with log toe-slope full pool bench structures and boulder.

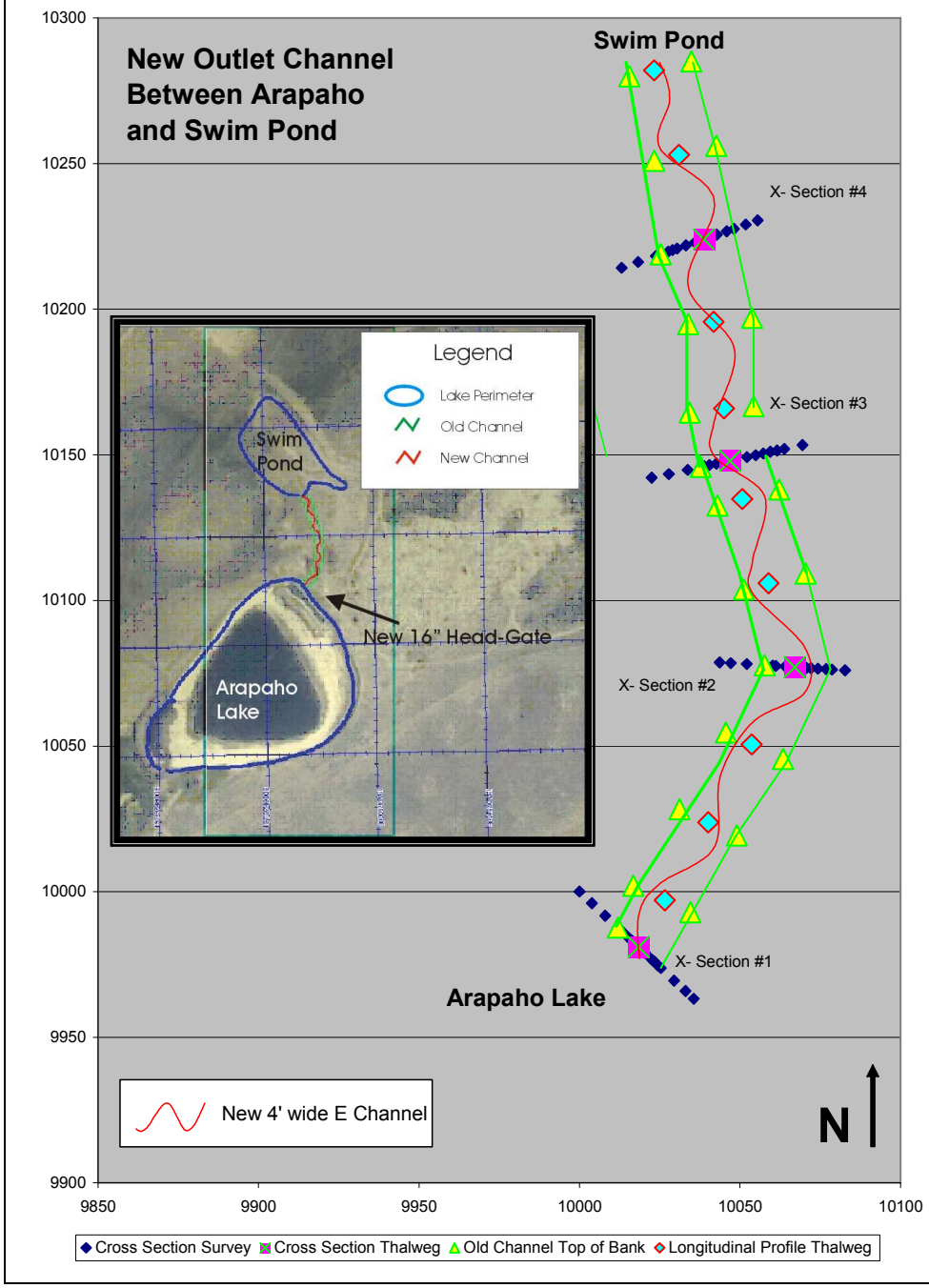


Diagram 2: Existing and new channel between Arapaho Lake and the Swim Pond.

A new "E" channel, three feet wide, will be excavated along a moderately meandering line within the confines of the old channel to the Swim Pond (Diagram 2). Transitional riffle crests between the meander bends will average 1.5 feet deep, and scour pools will be constructed at the meander bends approximately 2.5 feet deep (Diagram 3). The pool/riffle sequence will provide velocity and overhead cover required for fish passage when

the channel is in use. The new channel will be approximately 400 ft long, with an average slope of 0.75%. The capacity of the new channel is expected to be 27 to 30 cfs, depending on the final D84 particle size in the channel bottom. "E" channels typically exhibit steep, often undercut banks which provide ideal cover for trout. Extensive willow planting, using bare-root stock coyote or bar willow, will be accomplished along the banks to provide deep rooted vegetation and stable banks.
The outlet structure and new channel should be constructed before

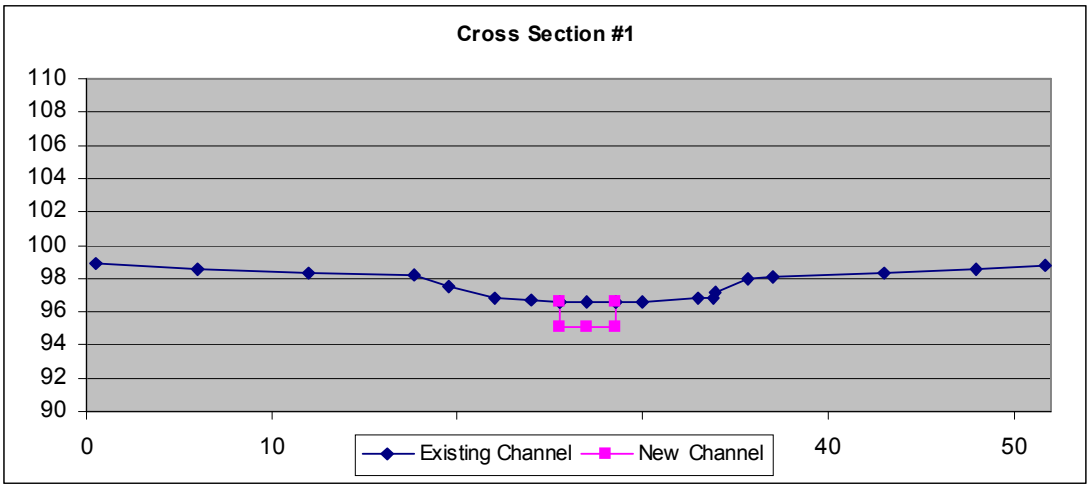


Diagram 3: X-Section #1 - Showing the new and existing channel between Arapaho and Swim Pond.

draining Arapaho Lake for dredging, in order to facilitate the draining of that lake. We propose to complete construction of the channel in October, 2007, and immediately begin draining the lake following this work. Shoreline and outlet work will require 5 - 6 days. Willow planting along the banks will need to be done in the early spring, just before the plants begin to emerge from a dormant state.

Dredging Plan:
Once the outlet structure and Channel reconstruction are complete, Arapaho Lake will be pumped dry, using a 5cfs floating pump placed along the deep channel on the northwest side of the lake. The pumped water will be piped to the newly constructed channel, and allowed to flow into the Swim Pond. It is likely that some water may need to be released from the Swim Pond in order to provide additional storage capacity.

As the lake reaches dead-pool storage, fish salvage will be accomplished by seining the excavated channels along the south and west, and north sides of the lake. Any fish captured will be transferred to the Swim Pond, which, until this point, has never been stocked. It is anticipated that enough fish can be salvaged from Arapaho Lake that stocking of the Swim Pond will not be required for the foreseeable future. Some incidental mortality of fish can be expected from the draining operation.

Excavation will commence in late January or early February of 2008. A plot of the proposed dredging areas is shown in Diagram 4. The littoral zones along the shoreline of the lake will be excavated approximately 1 - 1.5 ft in depth, in order to eliminate the seed bed for watermilfoil and other aquatic nuisance weeds in these areas. Deeper profundal habitats connecting the existing shoreline trenches will be created in the center of the lake by excavating 3-4 ft of lake bed material. The total estimated material to be removed from the lake is 12,500 yd^3. This will increase the capacity of the lake by 7.75 acre/feet.

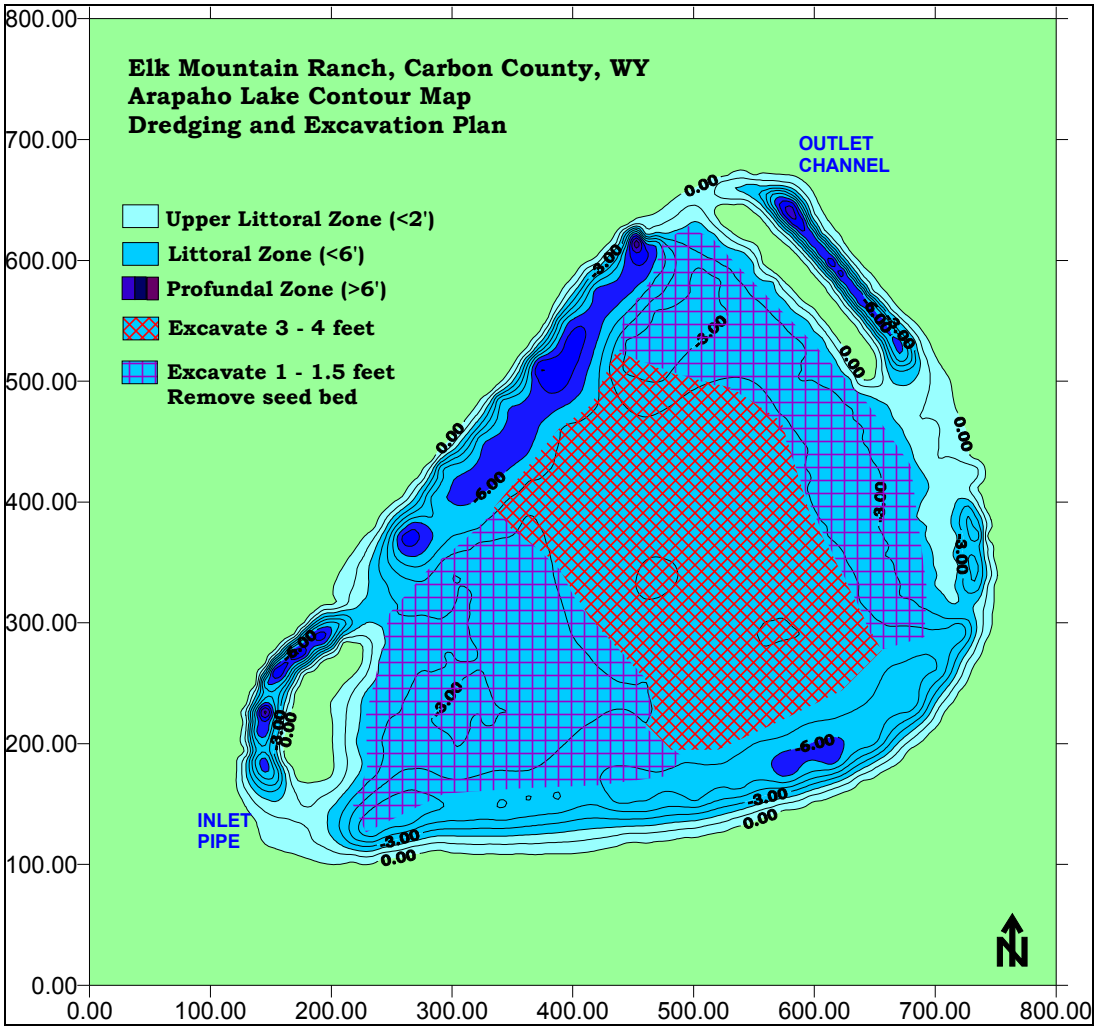


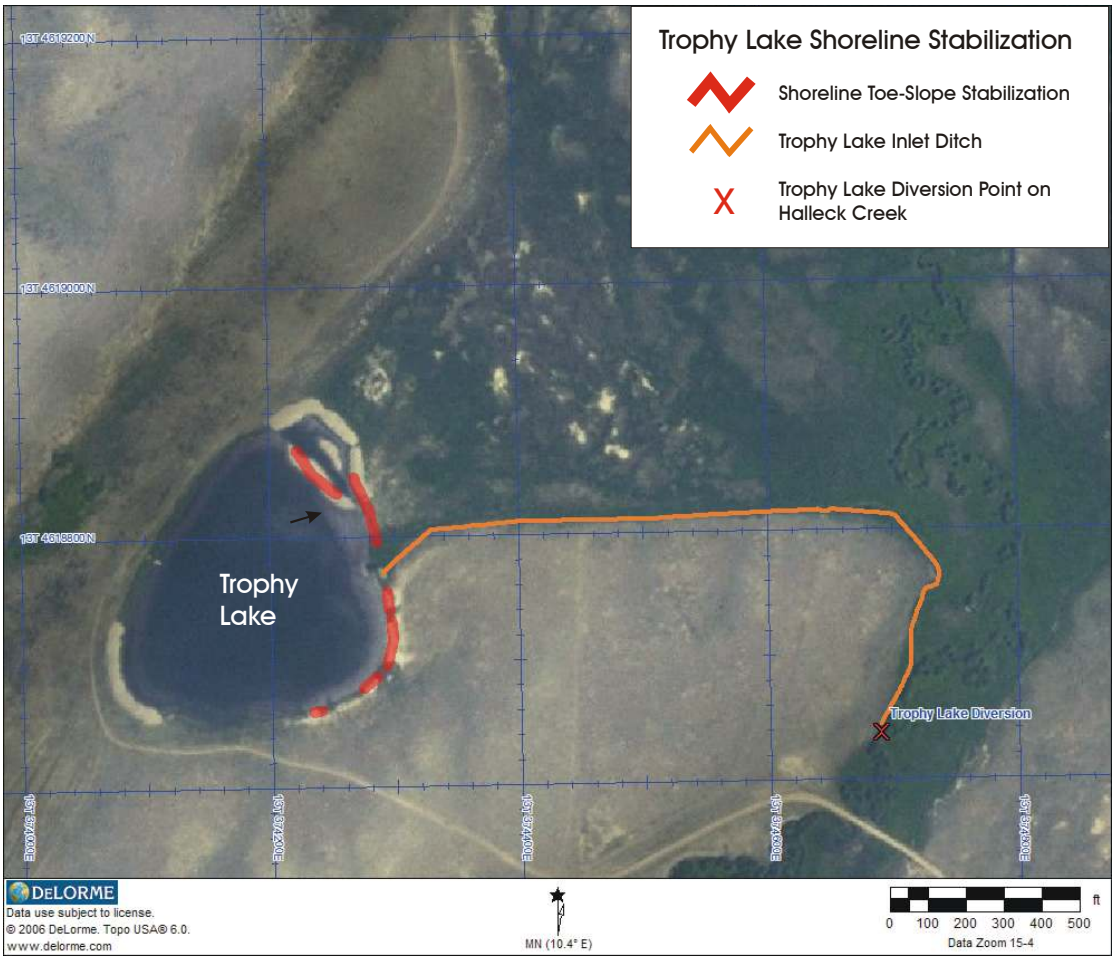
Diagram 4: Dredging and Excavation Plan for Arapaho Lake

The excavated lake bed material will be hauled to Borrow Pit #1, the closest of the pits to Arapaho Lake. On-site volume measurements indicate that Borrow Pit#1 will have enough capacity to hold all of the excavated materials, as well as the remaining old dredging piles and the spoils from the newly constructed "E" channel between the lakes. We estimate that the excavation work will require 9 - 10 days to complete.

After the lake has been excavated, a few large trees may be anchored in the deeper areas, using Manta-Ray or similar dead-man anchors to prevent the trees from floating to the surface. These trees will add important habitat complexity and cover for smaller juvenile fishes and forage organisms.

TROPHY LAKE

Shoreline Stabilization:
Trophy Lake exhibits severe erosion along its northeast and southeast shorelines, and along the south shore of the island constructed on the north side of the lake. Six sites were identified in May 2007 along the shoreline for stabilization treatments. Approximately 600 feet of the lake shoreline will need to be treated using the log toe slope stabilization techniques described in the preceding section (Map 4).



Map 4: Location of shoreline stabilization treatments on Trophy Lake.

Approximately 20 trees will be needed for the Trophy Lake shoreline stabilization work. Sedge mats may be harvested from the riparian area immediately downstream of the lake, and from the inlet ditch cleaning

work described in the next section. Additional coyote or bar willow may need to be purchased from a nursery and planted along the restored shorelines. Bare-root stock willow planting should be done in the early spring, just before the plants begin to emerge from dormancy.

Inlet Ditch Improvements:
The existing inlet ditch from Halleck Creek to Trophy Lake has become overgrown with vegetation, and is barely defined near the inlet with the lake. The diversion at Halleck Creek is in poor condition (Photo 8), and does not appear to function well at base flows typically found during the late summer and fall. The inlet ditch is 2,038 ft long and averages approximately 1 foot in width. The slope of the existing channel is approximately 1%.

A boulder cross-vane structure will be constructed immediately downstream of the existing diversion on Halleck Creek. The cross vane will require 20 to 25 large boulders, and will raise the base flow stage of the creek at the diversion point by approximately 0.4 feet, ensuring that the diversion can be utilized throughout the base flow periods in late summer and fall. Boulders will be harvested from the Rattlesnake Pass and 4 Corners areas identified in the Lower Rattlesnake Creek Restoration Plan (FIN-UP, Inc., 2007). A 16" head-gate and twenty foot long culvert will be installed at the diversion, replacing the existing sliding gate that is in disrepair. The culvert will be back-filled to the existing grade of the surrounding stream bank, and the head-gate will be armored with boulder to sustain above bank-full flows without overtopping.


Photo 8: Existing Trophy Lake Diversion


Photo 9: Diversion ditch to Trophy Lake..

The inlet ditch (Photo 9) between the diversion structure and Trophy Lake will be cleaned of all vegetation and widened to approximately 2 ft. All vegetation harvested during the ditch cleaning will be utilized to establish vegetation along the newly constructed shoreline stabilization structures.

Shoreline stabilization and inlet ditch work can be completed in October, 2007, and is expected to take 5 - 6 days. Bare-root stock willow planting along the shorelines will need to be done in the early spring, just before the plants begin to emerge from a dormant state.

Dredging Plan:
Trophy Lake has considerable dead-pool storage capacity, and will be pumped dry, using a 5cfs floating pump placed along the previously dredged channel on the north side of the lake. After the lake has been drawn down to a level 3 ft below full pool, the pump will need to be relocated to the main pool of the lake. The pumped water will be piped to the wetlands immediately below the lake, where it will eventually flow back into Halleck Creek. It is estimated that it will take up to one week to completely drain the lake using the floating pump, depending on the density of the aquatic weeds in the lake. If the lake is drained during the late fall, aquatic weeds should have died off and will present less of an impediment to the pumping operations. It is important that Trophy Lake be pumped dry after Arapaho Lake, in order to reduce the risk of spreading Eurasian watermilfoil to another lake. Once the lake has been drawn down approximately 9 ft from full pool level, fish salvage will be accomplished by seining the remaining dead-pool of the lake. Any fish captured will be transferred to the Tatanka Lake, which has not been stocked since 2002. If a greater number of fish are salvaged than expected, some of the fish may be transferred to Eagle Lake. Some incidental mortality of fish can be expected from the draining operation.

Excavation may commence in mid February of 2008. A plot of the proposed dredging areas is shown in the Diagram 5. Trophy Lake currently exhibits good deep water, profundal habitat to littoral habitat ratios, therefore dredging for depth will not be necessary in the lake. Excavation of Trophy Lake will focus primarily of removing the existing seed bed for Eurasian Watermilfoil and other aquatic nuisance weed species. It is expected that at 1.5 - 2 feet of the lake bed will need to be excavated and removed from the site. The total estimated material to be removed from the lake is 21,000 yd^3. This will increase the storage capacity of the lake by 13.25 acre/feet.

The excavated lake bed material will be hauled to the Cow Pit, the largest of the borrow pits, located at the northeast corner of the ranch. While the Cow Pit is a longer travel distance from Trophy Lake than the other

pits on the ranch, it is an ideal location for storing these Eurasian watermilfoil laced lake sediments, as it is located the farthest from any water sources. Additionally, spoils from the Trophy Lake dredging project are expected to fill only half of the volume of the Cow Pit, allowing us to cover these sediments with additional dredged sediments from other lakes on the property that are not infested with Eurasian watermilfoil. Although these sediments will be eventually covered with additional material from further dredging activities in subsequent years, it is recommended that the area be seeded with a temporary annual grass mix to reduce the potential for airborne dispersal of aquatic weed seeds or colonization by terrestrial weed species.

We estimate that the excavation work will require 16 - 17 days to complete. After the lake has been excavated, several large trees should be anchored in the deeper regions of the lake, using Manta-Ray or similar dead-man anchors to prevent the trees from floating to the surface. These trees will add important habitat complexity and cover for smaller juvenile fishes and forage organisms.

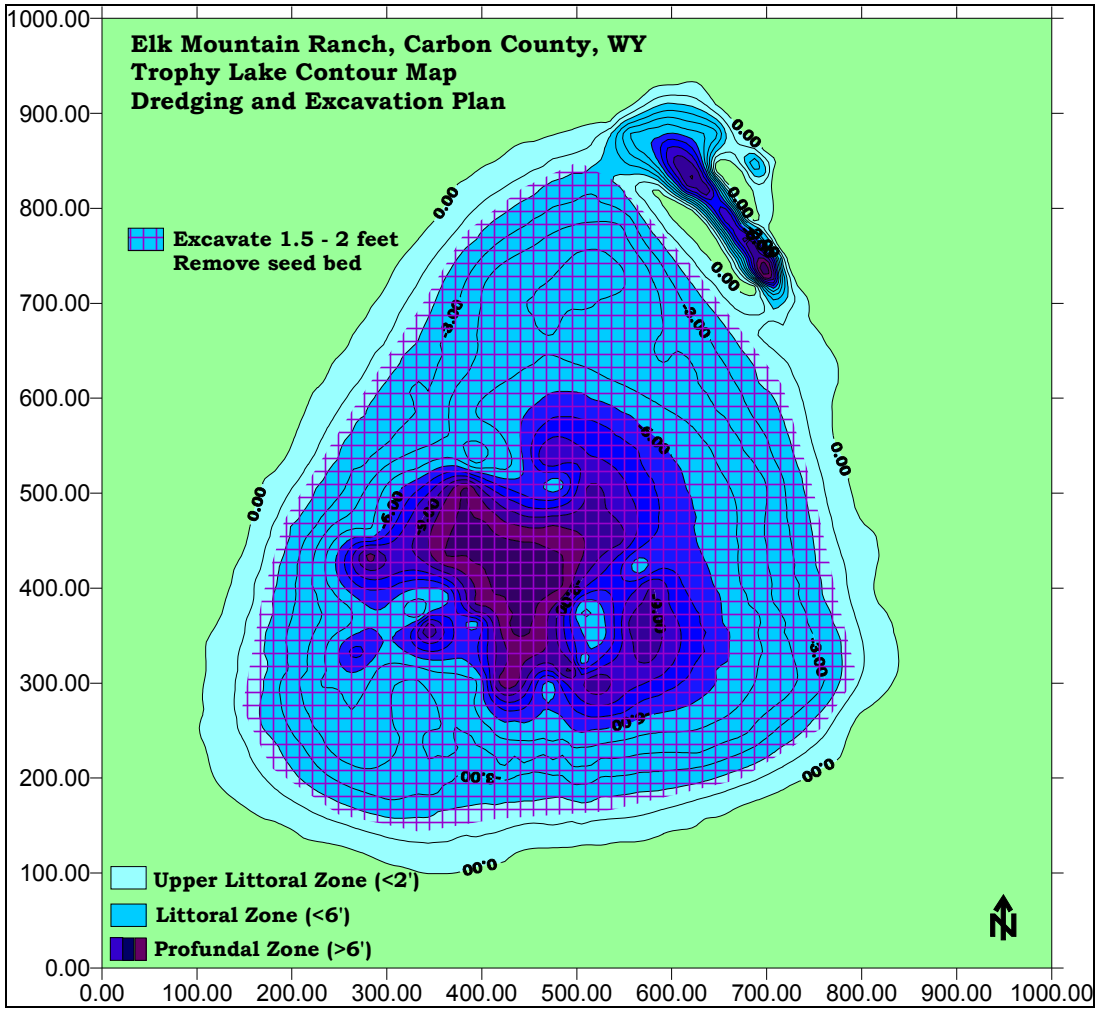


Diagram 4: Dredging and Excavation Plan for Trophy Lake

EAGLE LAKE

Shoreline and Dam Face Stabilization:
Eagle Lake exhibits severe erosion along its north and east shorelines, and along the west shore of the island constructed on the east side of the lake. The island is particularly unstable (Photo 10), and is rapidly eroding back into the lake. Spoils piles left over from the 2003 dredging are collapsing into the lake, and need to be shaped, graded, and re-seeded, with excess spoils being hauled to one of the borrow pits identified in this document, or used to stabilize the erosion gullies on the downstream face of the dam. Approximately 5,725 yd^3 of material will need to be removed from the eastern shore of the lake. The island elevation will be lowered approximately 4 - 5 feet, matching the existing landscape elevation of the shorelines, requiring removal of another 1,060 yd^3 of materials. Approximately 550 feet of the lake shoreline along the east shore will need to be treated using the log toe slope stabilization. Another 300 feet of similar shoreline treatments will be installed on the west shoreline of the island once the excess materials have been removed (Map 5).

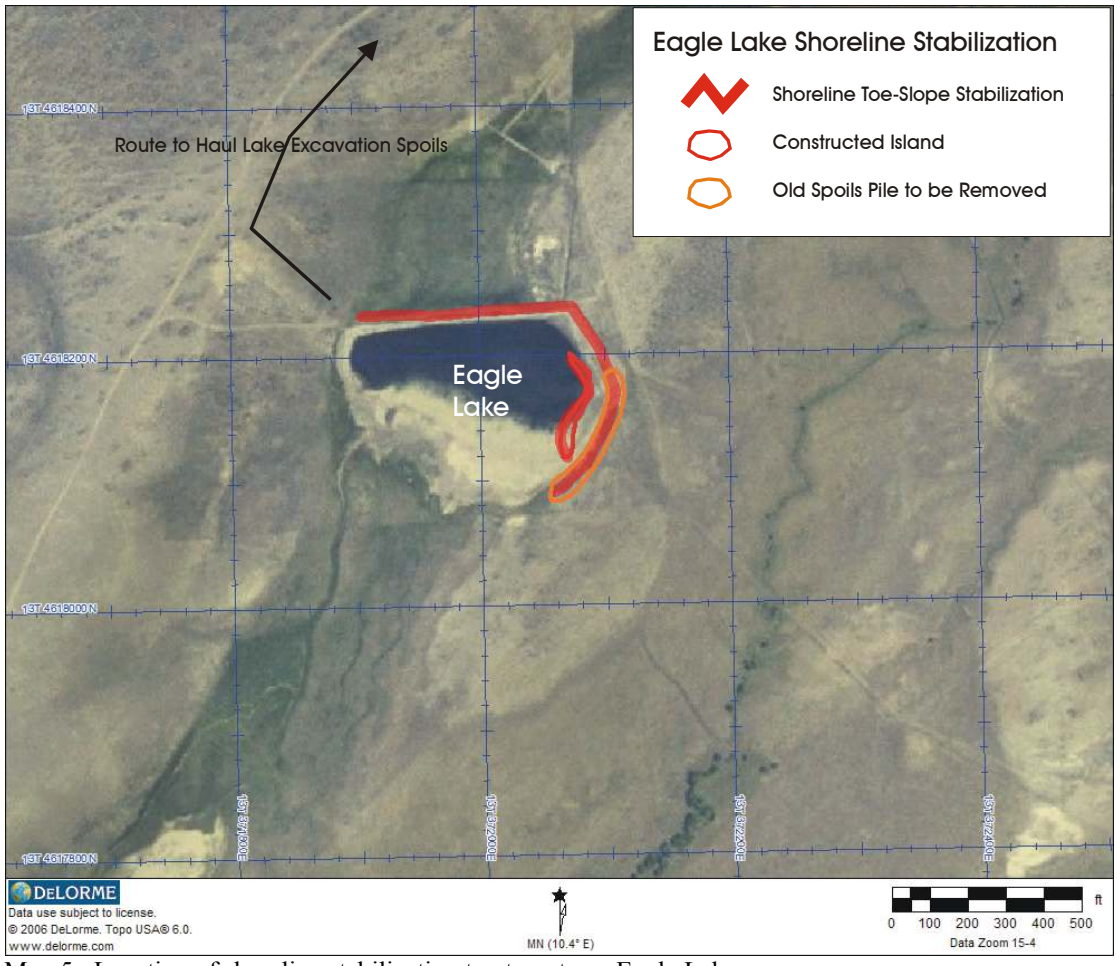

Photo 10: Eroding Island at Eagle Lake

The lakeside face of the earthen dam on the north shore of Eagle Lake is in relatively poor condition, with several slope failures apparent along the length of the dam (Photo 11). Additionally, several gullies have formed on the downstream side of the dam (Photo 12), and will need to be treated in order to ensure the integrity of the structure. While the dam is not large enough to be considered "jurisdictional", it is still recommended


Photo 11: Lakeside Dam Face.


Photo 12: Eroding Downstream side of Dam.

that best management practices for this type of structure be followed, including removal of deep rooted woody vegetation along the faces of the dam. We recommend harvesting willow and other woody species from the dam and using these plants for shoreline re-vegetation along the eastern shore of the lake. Approximately 1,800 yd^3 of 12" - 16" rip-rap will be placed along the lakeside face of the dam to provide armoring of the shoreline and stabilization of the dam face. Rip-rap does not appear to be readily available on the ranch, and may need to be purchased from a nearby quarry and hauled to the site.



Map 5: Location of shoreline stabilization treatments on Eagle Lake.

Approximately 30 trees will be needed for the Eagle Lake shoreline stabilization work. Sedge mats may be harvested from the riparian area immediately downstream of the lake. Additional coyote or bar willow may need to be purchased from a nursery and planted along the restored shorelines. Bare-root stock willow planting should be done in the early spring, just before the plants begin to emerge from dormancy.

Shoreline stabilization and island leveling work can be completed in October, 2008, and is expected to take 5 - 6 days. Bare-root stock willow

planting along the shorelines will need to be done in the early spring, just before the plants begin to emerge from a dormant state.

Dredging Plan:
Eagle Lake may be drawn down in late summer of 2008, using the existing outlet structure on the dam. Removal of dead-pool storage will be accomplished using a 5cfs floating pump placed along deep channel on the north side of the lake. The pumped water will be piped to the wetlands immediately below the lake, where it will eventually flow back into Halleck Creek. It is estimated that it will take up to one week to completely drain the lake using the floating pump, depending on the density of the aquatic weeds in the lake. If the lake is drained during the late fall, aquatic weeds should have died off and will present less of an impediment to the pumping operations.

Once the lake has been drawn down approximately 7 ft from full pool level, fish salvage will be accomplished by seining the remaining dead-pool regions on the north and east sides of the lake. Any fish captured will be transferred to the Trophy and Arapaho Lake, which will have been refilled during the summer of 2008. Some incidental mortality of fish can be expected from the draining operation.

Excavation may commence during the winter of 2009. A plot of the proposed dredging areas is shown in the Diagram 5. The littoral zones along the south shoreline of the lake will be excavated approximately 1 - 1.5 ft in depth, in order to eliminate the seed bed for watermilfoil and other aquatic nuisance weeds in these areas. The deeper profundal region of the lake adjacent to the dam will be expanded by excavating more material from the center of the lake. Approximately 3 ft of lake bed material will be removed from the center of the lake, with the lake bottom gradually rising to the littoral zone along the south side of the impoundment. The total estimated material to be removed from the lake is 24,000 yd^3. This will increase the capacity of the lake by 14 acre/feet.

Eagle Lake is located the farthest from any of the borrow pit storage areas, and presents the greatest challenge for efficient removal of spoils from the site. We recommend that the excavated lake bed material will be hauled to the Cow Pit, using the ranch two-track road that leads north from Eagle Lake to the Rattlesnake Pass Road, then east along the county road to the borrow pit at the northeast corner of the ranch. Volume calculations indicate that the Cow Pit will have enough capacity to hold all of the excavated materials, as well as the remaining old dredging piles and the spoils from lowering the island on the eastern side of the lake. We estimate the excavation work at Eagle Lake may take up to 25 days, due to the hauling distances involved.

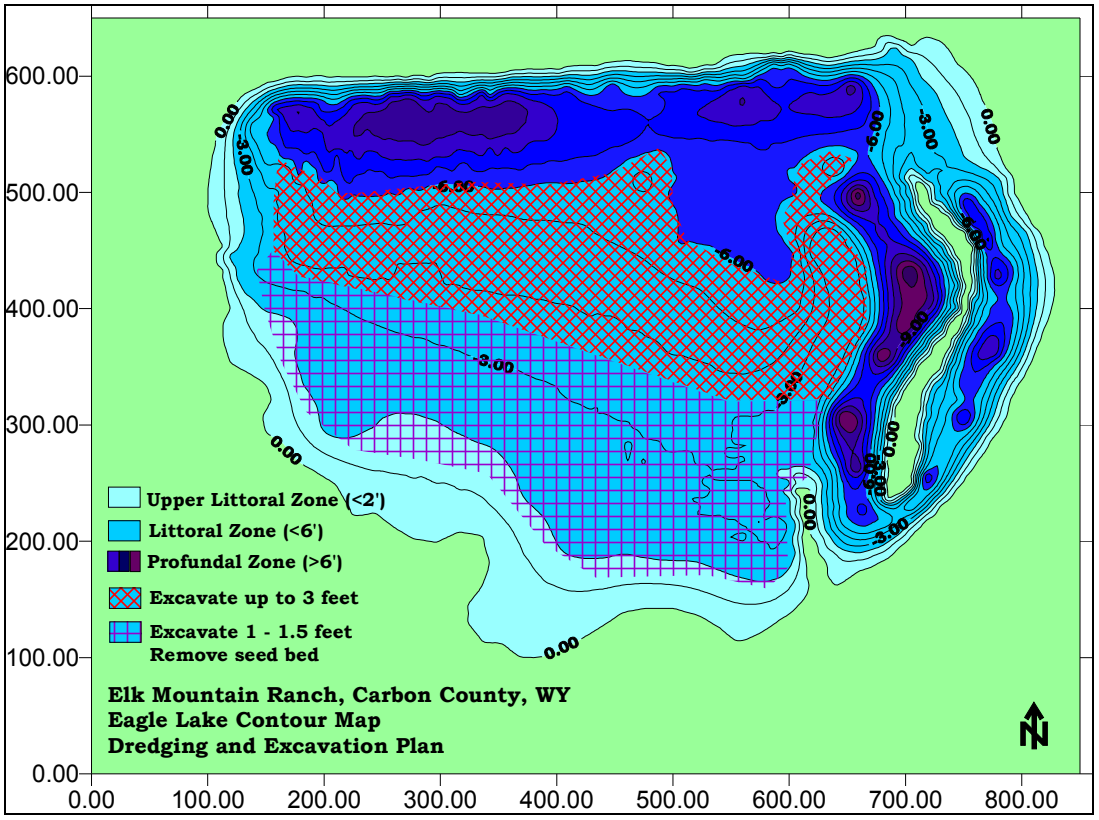


Diagram 5: Dredging and Excavation Plan for Eagle Lake

After the lake has been excavated, several large trees should be anchored in the deeper regions of the lake, using Manta-Ray or similar dead-man anchors to prevent the trees from floating to the surface. These trees will add important habitat complexity and cover for smaller juvenile fishes and forage organisms.

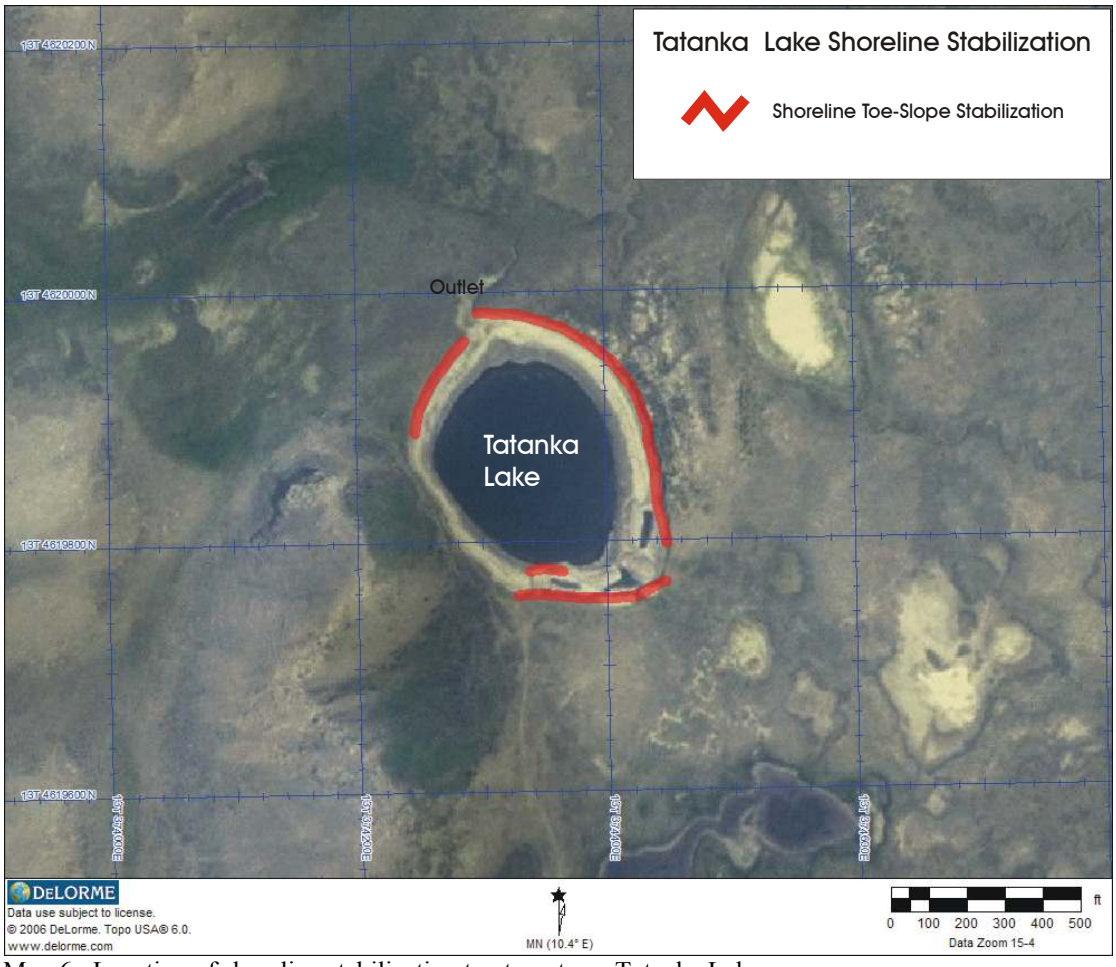
TATANKA LAKE

Shoreline and Dam Face Stabilization:
Tatanka Lake exhibits severe erosion along its north, east, and south shorelines, and along the north shore of the island constructed on the south side of the lake (Photo 13). Four shoreline segments, totaling


Photo 13: North shoreline of Tatanka Lake

approximately 1,550 feet of the lake shoreline will need to be treated using root-wad revetment and log toe slope stabilization techniques (Map 6). Additionally, the steep, unvegetated slopes above the eroding shorelines on the north and southeast shore of the lake need to be pulled back, re shaped and stabilized using either geo-textile or coconut jute fabric to allow vegetation to re-establish on these slopes.

Approximately 50 - 55 trees will be needed for the Tatanka Lake shoreline stabilization work. Sedge mats may be harvested from the riparian area immediately east of the lake. Additional coyote or bar willow may need to be purchased from a nursery and planted along the restored shorelines. Bare-root stock willow planting should be done in the early spring, just before the plants begin to emerge from dormancy.



Map 6: Location of shoreline stabilization treatments on Tatanka Lake.

Shoreline stabilization and island leveling work can be completed in October, 2008, and is expected to take 4 - 5 days. Bare-root stock willow planting along the shorelines will need to be done in the following early spring, just before the plants begin to emerge from a dormant state.

Dredging Plan:
Tatanka Lake may be drawn down in late summer of 2008. The lake has an uncontrolled outlet, with considerable dead-pool storage capacity, and will be pumped dry, using a 5cfs floating pump placed in the main pool of the lake. The pumped water will be piped to the wetlands immediately north of the lake, where it will eventually flow back into Halleck Creek. It is estimated that it will take 1- 2 days to completely drain the lake using the floating pump, depending on the density of the aquatic weeds in the lake.
Once the lake has been drawn down approximately 8 ft from full pool level, fish salvage will be accomplished by seining the remaining dead-pool regions on the north and east sides of the lake. Any fish captured will be transferred to Trophy Lake, which will have been refilled during the summer of 2008. Some incidental mortality of fish can be expected from the draining operation.

Excavation may commence during the winter of 2009. A plot of the proposed dredging areas is shown in the Diagram 6. Tatanka Lake currently exhibits adequate deep water, profundal habitat to littoral

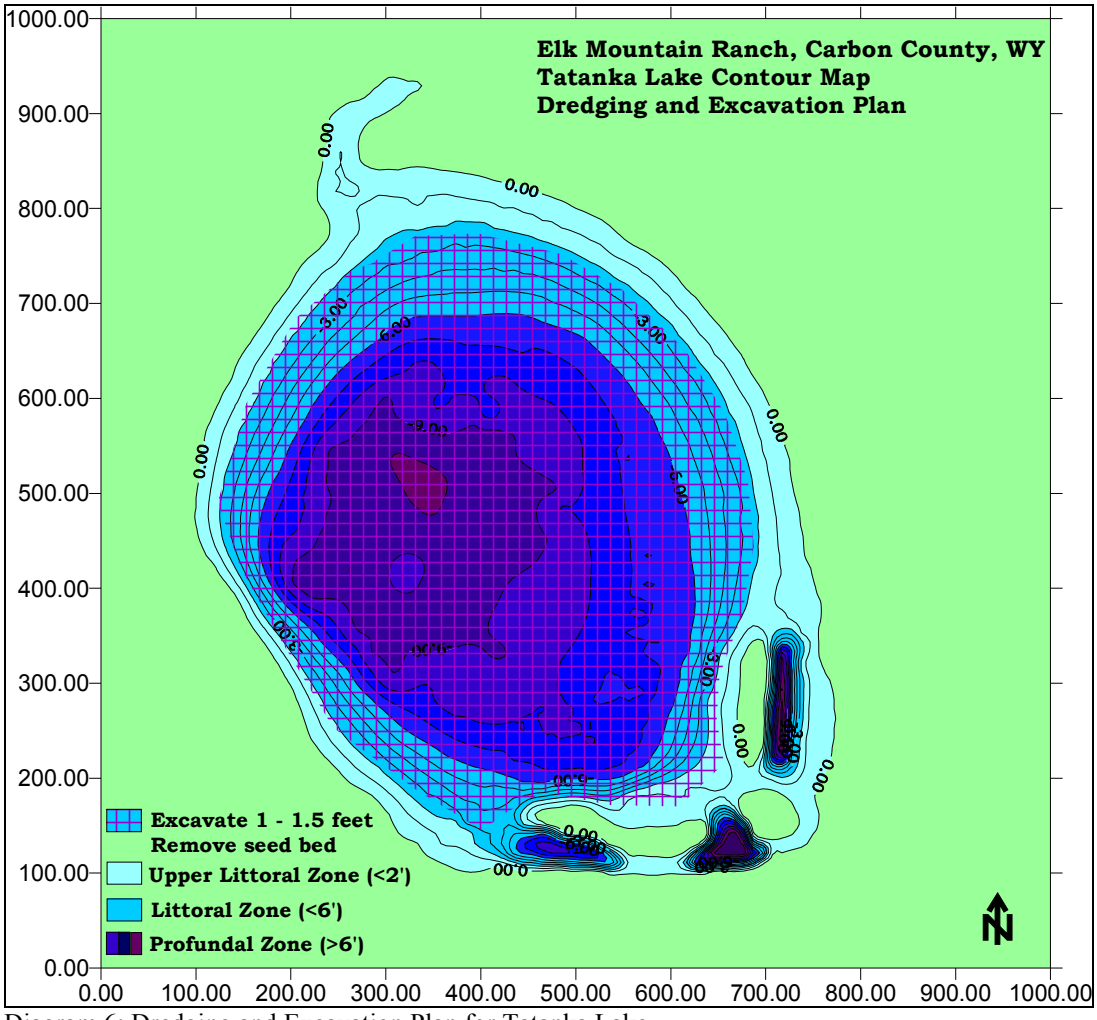


Diagram 6: Dredging and Excavation Plan for Tatanka Lake

habitat ratios, therefore dredging for depth will not be necessary in the lake. Excavation of Tatanka Lake will focus primarily of removing the existing seed bed for Watermilfoil and other aquatic nuisance weed species. It is expected that at 1 - 1.5 feet of the lake bed will need to be excavated and removed from the site. The total estimated material to be removed from the lake is 12,500 yd^3. This will increase the storage capacity of the lake by 8 acre/feet.

The excavated lake bed material will be hauled to Borrow Pits #3 - #6, the closest of the pits to Tatanka Lake. We estimate that these pits will have enough capacity to hold all of the excavated materials. Excavation is expected to take approximately 10 days.

After the lake has been excavated, several large trees should be anchored in the deeper regions of the lake, using Manta-Ray or similar dead-man anchors to prevent the trees from floating to the surface. These trees will add important habitat complexity and cover for smaller juvenile fishes and forage organisms.

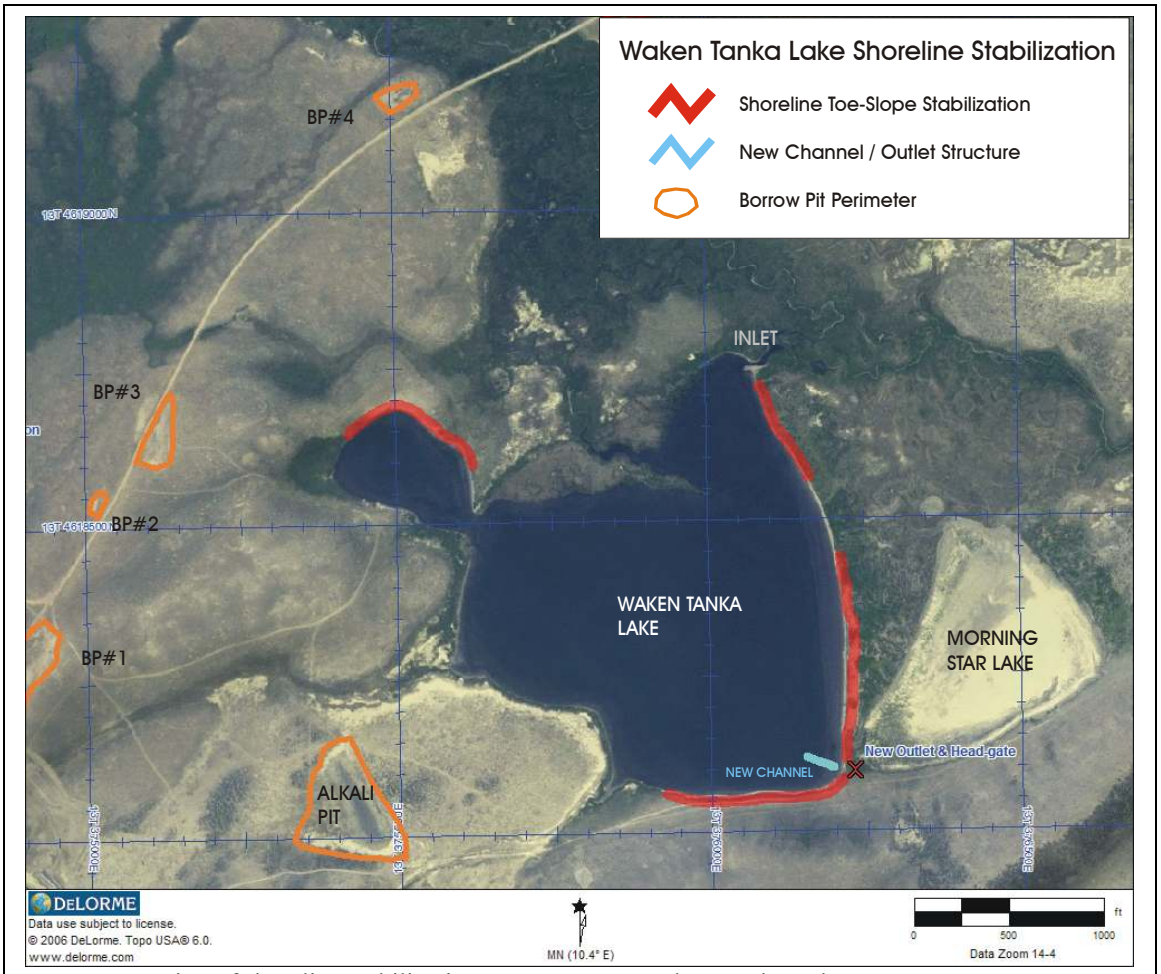
WAKEN TANKA LAKE

Shoreline and Dam Face Stabilization:

Waken Tanka Lake exhibits severe erosion along its east, and south shorelines, and along the north shore of the smaller pool on the northwest side of the lake. Four shoreline segments, totaling approximately 2,990 feet of the lake shoreline need to be treated using root-wad revetment and log toe slope stabilization techniques (Map 7). Additionally, the twenty foot high, nearly vertical slopes above the eroding shorelines on the eastern shore of the lake (Photo 14) need to be re shaped to a 3-1 slope or less, and stabilized using either geo-textile or coconut jute fabric to allow vegetation to re-establish on these slopes.

Photo 14: Eastern shore of Waken Tanka Lake.

Shoreline stabilization and island leveling work can be completed during the summer or fall of 2008, and is expected to take 8 - 10 days. At least 100 trees will be needed for the Waken Tanka Lake shoreline stabilization work. Areas for sedge mat harvest can be found immediately east of



Map 7: Location of shoreline stabilization treatments on Waken Tanka Lake.

the lake. Several hundred additional coyote or bar willow may need to be purchased from a nursery and planted along the restored shorelines. Bare-root stock willow planting should be done in the following early spring, just before the plants begin to emerge from dormancy.

Outlet Improvements:

The existing outflow channel from Waken Tanka Lake to Morning Star Lake can only function during a brief period in the spring, when Waken Tanka Lake is at full pool level due to snowmelt run-off. Constructing a new outlet structure and a deep water channel extending into Waken Tanka Lake may allow water may be transferred to the Morning Star Lake at critical times during the late summer and fall, allowing full use of this impoundment. A new channel, approximately 15 - 20 feet wide and three feet deep, will need to be excavated extending from the outlet into the deeper regions of Waken Tanka Lake (Diagram 7). This excavated channel will be approximately 150 ft long, and require removal of approximately 250 yd of material, which will need to be completely removed from the site and hauled to one of the borrow pits. This work

can probably be down without additional draining of the lake, if done in the late summer or fall when the lake is relatively low.

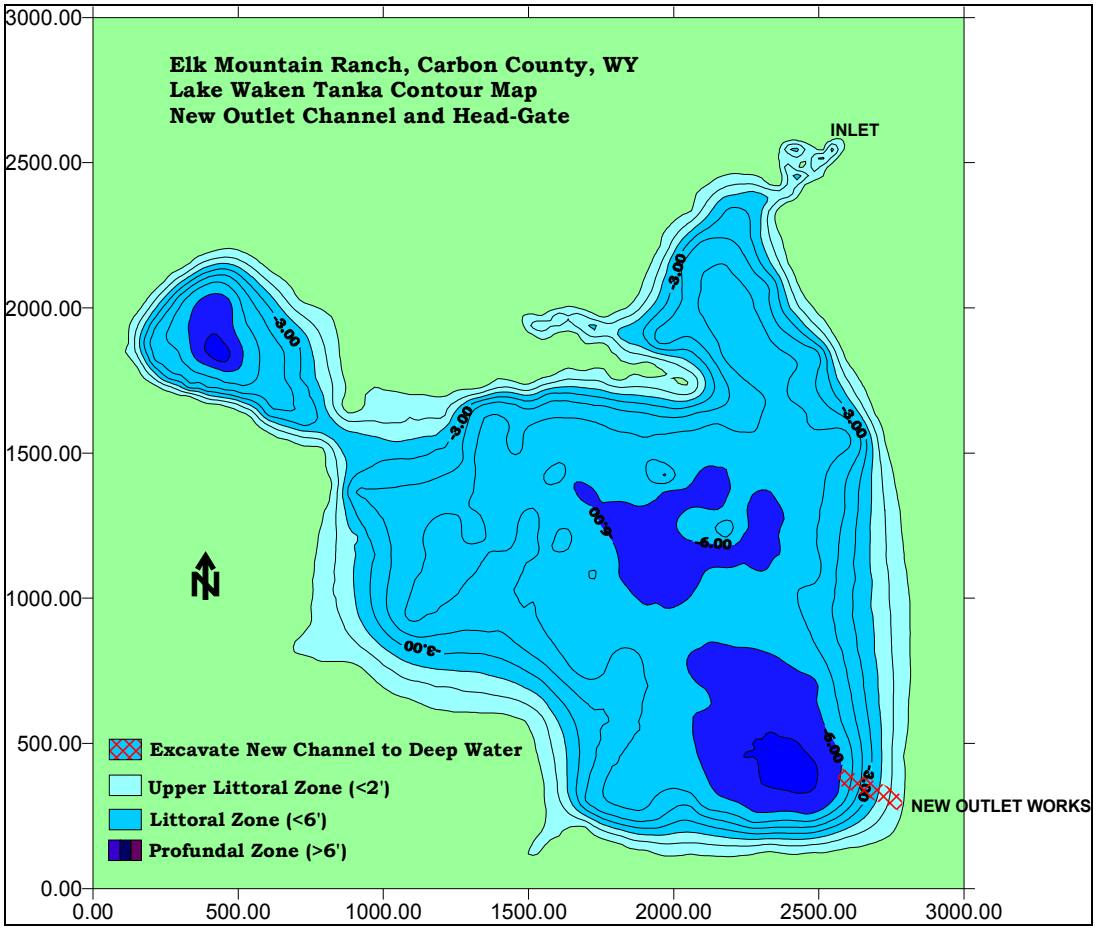


Diagram 7: New Outlet Channel for Lake Waken Tanka.

A 16" head-gate and twenty foot long culvert may be installed at the outlet of Waken Tanka Lake, at an elevation matching the lowest elevation of the newly excavated channel in the lake. The culvert will be back-filled to a level 1 foot below the existing grade of the surrounding landscape, to allow for overflow in the event of flooding conditions, and the shoreline will be armored with log toe-slope full pool bench structures and boulder.

MORNING STAR LAKE

Dredging Plan:
If the outlet improvements are undertaken at Waken Tanka Lake, the ranch may find it desirable to consider dredging the center of Morning Star Lake and re-establish a trout fishery in the impoundment. The lake is currently dry, so draining would not be an issue. Excavation of the lake could occur in either the winter of 2008 or 2009.

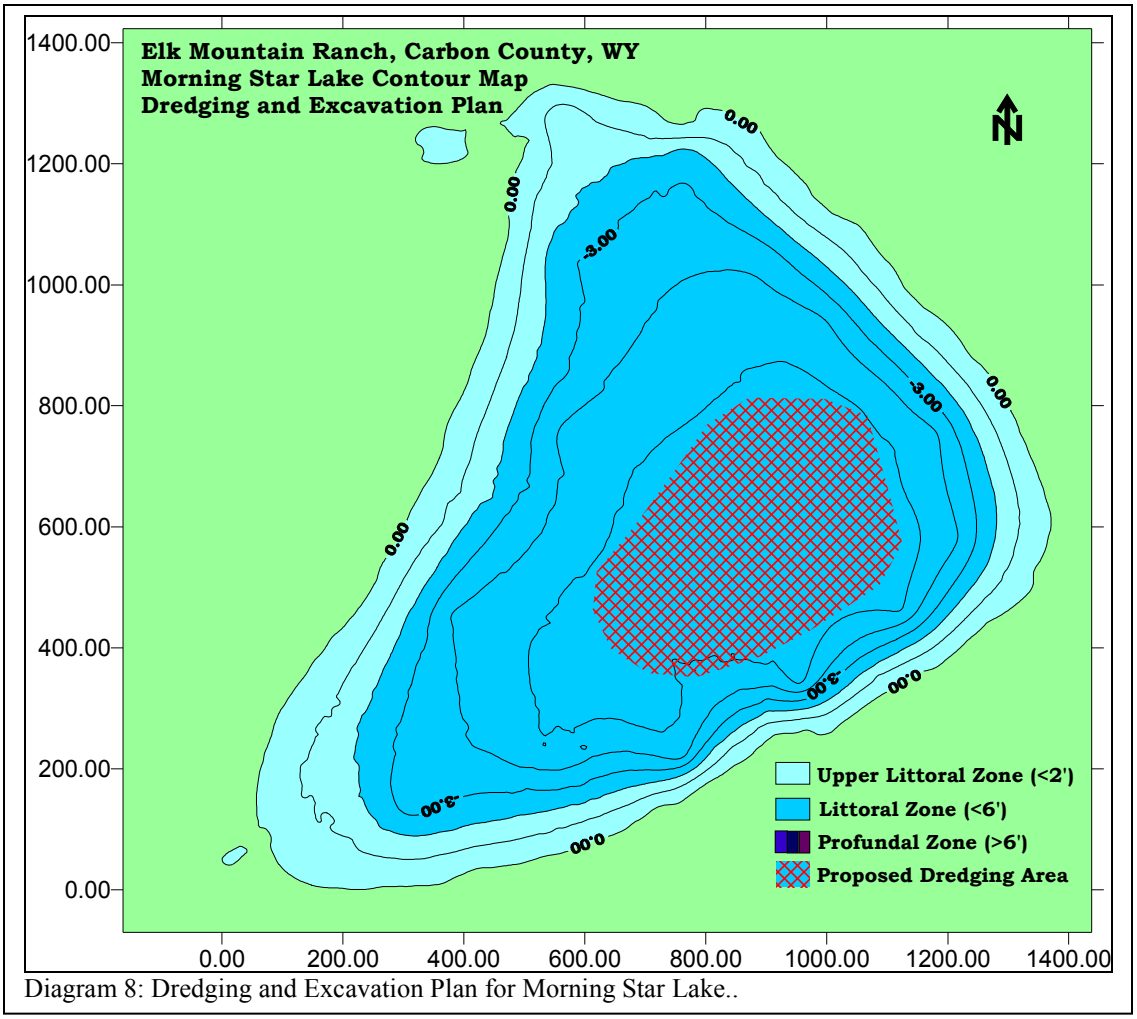


Diagram 8: Dredging and Excavation Plan for Morning Star Lake..

A plot of the proposed dredging area is shown in the Diagram 8. Excavation would focus on increasing deep water, profundal habitat zones in the center of the lake. The total estimated material to be removed from the lake is 25,000 yd^3. This will increase the storage capacity of the lake by 15.5 acre/feet.

The excavated lake bed material will likely exceed the remaining capacity of the ten borrow pits and the Cow Pit, requiring the use of the abandoned pond/alkali pit southwest of Waken Tanka Lake. Excavation of the lake will likely take approximately two weeks.

APPENDIX

Suggested Timeline for Completion of Project

Shoreline Stabilization Structure and Treatment Drawings

Photographic Representations of Treatment Types

References

SUGGESTED TIME-LINE FOR COMPLETION OF PROJECT

OCTOBER 2007

Harvest 55 -60 trees for Arapaho & Trophy Lake Shoreline Work
Collect 125 boulders for Arapaho & Trophy Lake Inlet & Outlet Work
Construct New Channel and Outlet Structure at Arapaho Lake
Install Shoreline Stabilization Structures at Arapaho Lake
Construct New Diversion for Trophy Lake Ditch - Clean Ditch
Install Shoreline Stabilization Structures at Trophy Lake
Drain Arapaho & Trophy Lakes - Salvage and Transfer Fish
Estimated Time Required: 2-3 Weeks

FEBRUARY 2008

Excavate Arapaho Lake
Excavate Trophy Lake
Grade Spoils in Borrow Pits
Estimated Time Required: 4 Weeks

MAY 2008

Re-Fill Arapaho and Trophy Lakes
Re-Seed Borrow Pits
Plant Bare-Root Stock Willow Along Treated Shorelines
Grade Spoils in Borrow Pits
Harvest 100 Trees for Waken Tanka Lake
Install Shoreline Stabilization Structures at Waken Tanka Lake
Estimated Time Required: 2 Weeks

OCTOBER 2008

Harvest 95 -100 trees for Eagle and Tatanka Lake Shoreline Work
Install Rip-Rap Along Lakeside Face of Eagle Lake Dam
Construct New Channel and Outlet Structure at Waken Tanka Lake
Install Shoreline and Island Stabilization Structures at Eagle Lake
Install Shoreline Stabilization Structures at Tatanka Lake
Drain Eagle & Tatanka Lakes - Salvage and Transfer Fish
Estimated Time Required: 2-3 Weeks

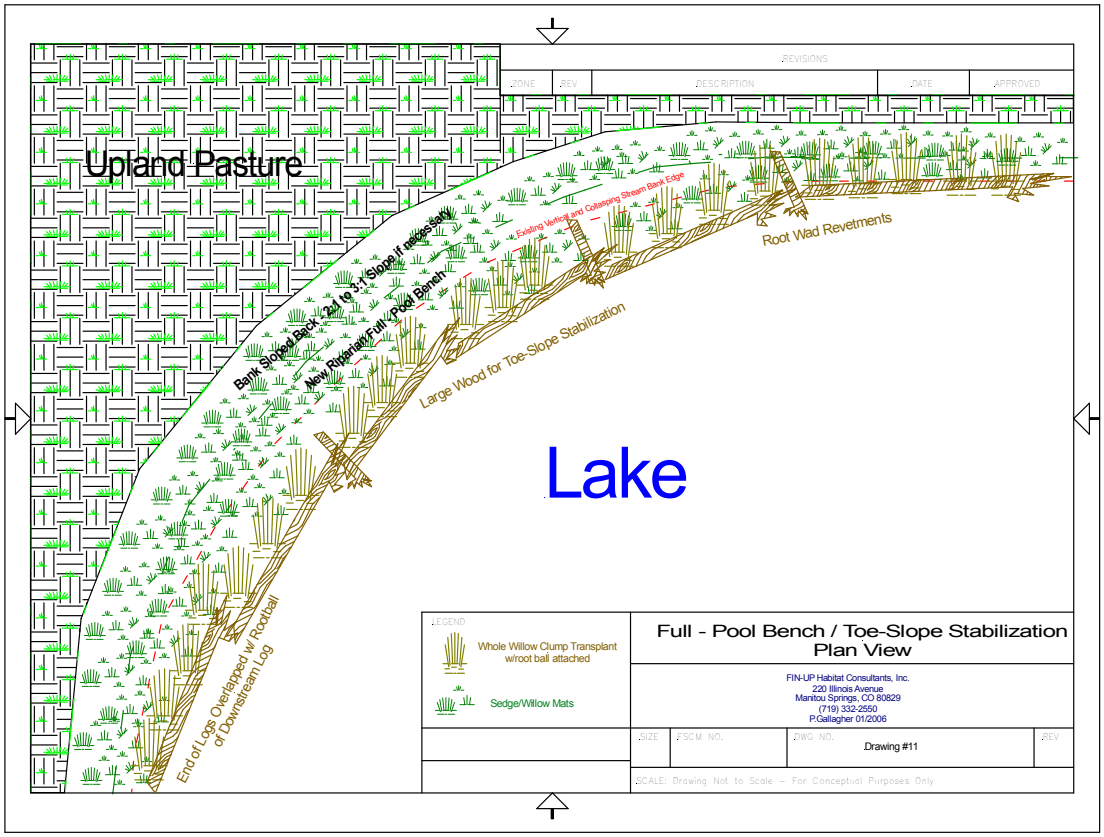
FEBRUARY 2008

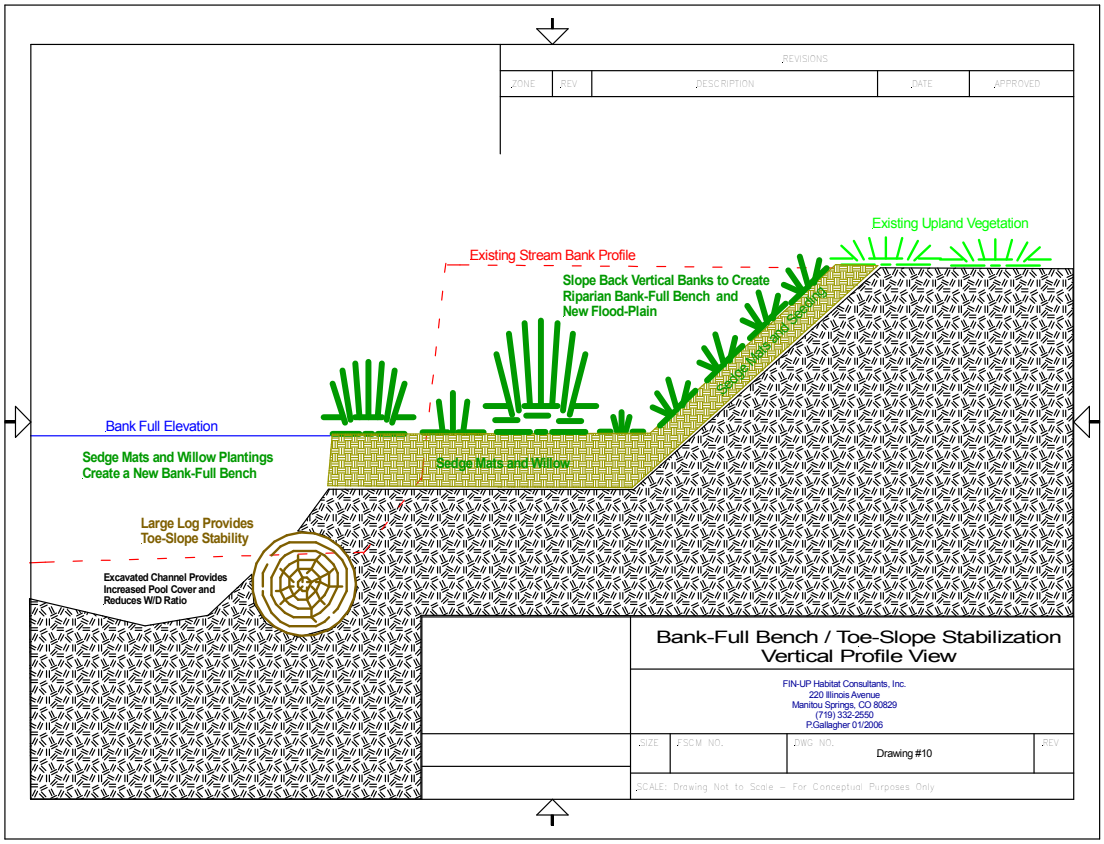
Excavate Eagle Lake
Excavate Tatanka Lake
Excavate Morning Star Lake
Grade Spoils in Borrow Pits
Estimated Time Required: 5 - 6 Weeks

MAY 2009

Re-Fill Eagle and Tatanka Lakes
Re-Seed Borrow Pits
Plant Bare-Root Stock Willow Along Treated Shorelines

SHORELINE STABILIZATION STRUCTURE DRAWINGS





Cottonwood trees used as toe-slope stabilization with riparian benches. Cucharas Creek, Huerfano County, Colorado.

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