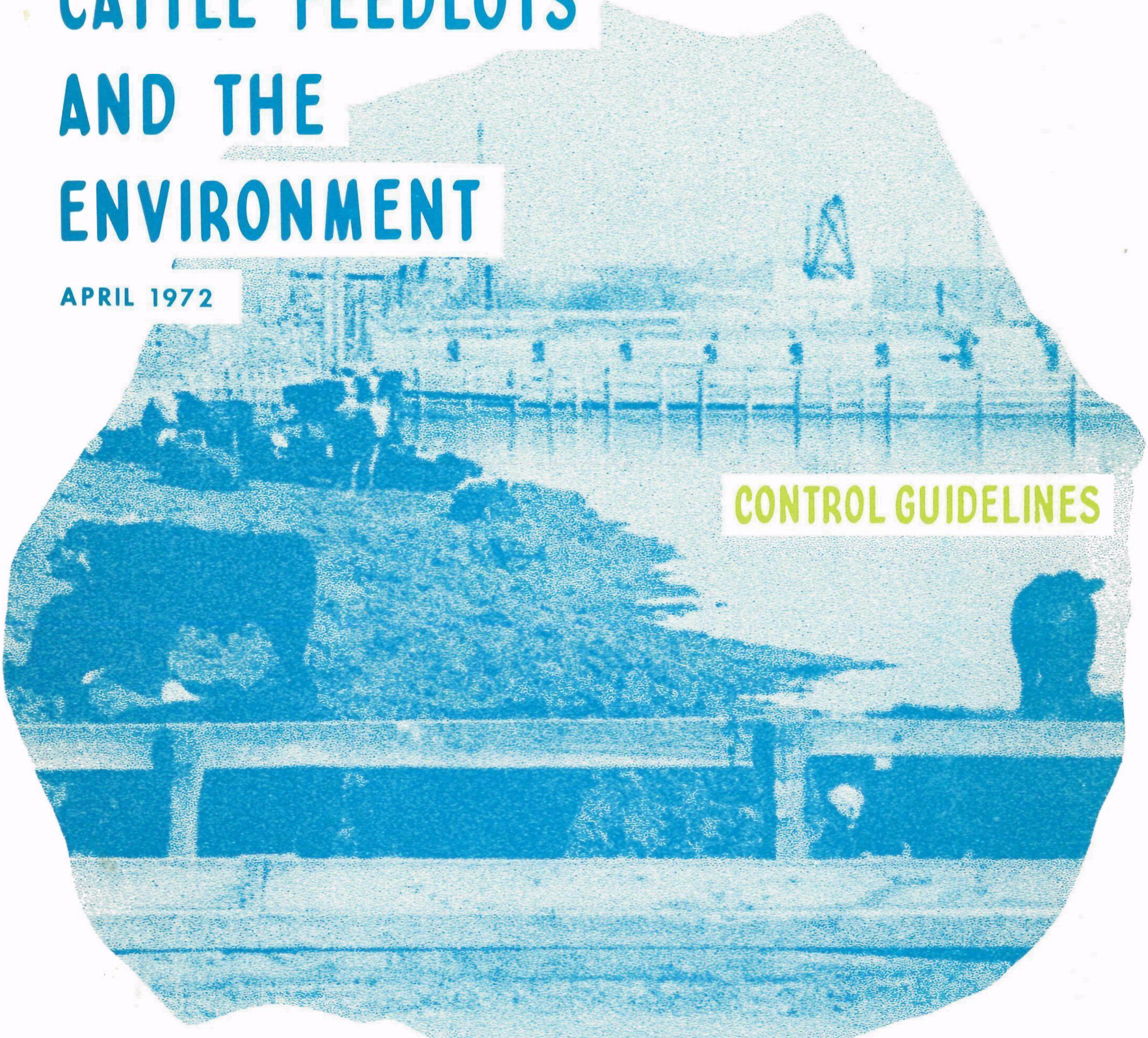
CATTLE FEEDLOTS AND THE ENVIRONMENT

APRIL 1972



CONTROL GUIDELINES

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

REGION X 1200 SIXTH AVENUE SEATTLE WASHINGTON 98101

U.S. ENVIRONMENTAL PROTECTION AGENCY
REGION X
1200 SIXTH AVENUE
SEATTLE, WASHINGTON 98101

April 20, 1972

LETTER OF TRANSMITTAL

Pollution from cattle feedlots is a serious problem in certain areas of Oregon, Washington, and Idaho. However, feedlots can be built and operated in a manner which will eliminate the majority of the pollution problems.

These guidelines have been prepared to assist in bringing cattle feedlot operations into harmony with the environment. The guidelines are a general statement of location, design, and operation recommendations for individual feedlot operators.

We in the Environmental Protection Agency appreciate the cooperation we have received from agencies of the Department of Agriculture, state and local governments, from the various Cattle Feeders Associations, and from individuals in preparing these guidelines.

James L. Agee

James L. Agee
Regional Administrator

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CATTLE FEEDLOTS AND THE ENVIRONMENT

Cattle feedlots are unsavory installations -- necessary but nonetheless unsavory. More important, feedlots create problems of air pollution, water pollution, esthetic impacts, noise problems, and rodents and insects.

Strong, unpleasant odors are the hallmark of feedlots. Dust and noise are the source of continuing complaints. Rats and flies are attracted to feedlot operations. Feedlot runoff also results in offenses to public health and fish life.

The bulk of cattle feedlot wastes is urine and manure. Manure is classed as a solid waste, but it is actually about fifty percent moisture. Certain constituents of these wastes are subject to leaching and percolation into the soil and substrata and may move downward and laterally into the ground water. Rain and melting snow runoff carry feedlot waste products into drains, creeks, and eventually into the larger streams and rivers.

Large cattle feedlots are relatively recent, rapidly growing enterprises and critical sources of water pollution in the Pacific Northwest States--Idaho, Oregon, and Washington. The trend is clearly toward even larger cattle feedlots.

An April 1969 survey recorded 1,391 cattle feedlots in the Northwest. Of this total, 154 were of capacities exceeding 1,000 head. Some have capacities in excess of 50,000.

A feedlot of 1,000 head is a concentrated source of potential environmental pollution. About ten acres will accommodate a feedlot of several thousand head. One head in a feedlot will produce 34 cubic feet of manure in one year. This is about 1.25 cubic yards per head, 1,250 cubic yards for 1,000 head, or 12,500 cubic yards for 10,000 head.

More meaningful, however, is a comparison of feedlot wastes with domestic sewage. A convenient measure for comparison is BOD--Biochemical Oxygen Demand. Organic wastes from people and cattle utilize oxygen in the process of decomposition. BOD is the measure of the oxygen required. In terms of wastes measured by BOD, one head in a feedlot is equivalent to six people in town. Consider what this means: A cattle feedlot of 1,000 head is equal to a town of 6,000 population in terms of the certain wastes produced, all on a ten acre plot of ground. Some feedlot waste characteristics have population equivalents as high as eighteen.

Cattle feedlots result in heavy concentrations of animal wastes that must be recognized as a serious source of water pollution and for which pollution abatement measures must be undertaken.

The Development of Cattle Feedlots

Cattle feedlots are a logical development as western agriculture has seen progressive evolution from family-sized, diversified farms toward large irrigated farms producing cash crops, livestock feed crops, and secondarily, food process wastes. In past years, the small diversified farmer relied on animal wastes as the source of nitrogen, phosphorus, potassium and other trace minerals to be returned to the soil to maintain its productivity. He rotated crops and pasture on his farm. Animal wastes, rich in nitrogen and other plant nutrients, were returned to his land from pastured cattle or collected from his barns and corrals to be spread and plowed into his fields.

The advent of commercial chemical fertilizers has changed the picture. Chemical fertilizers are plentiful, relatively inexpensive, and easy to apply. More efficient, heavier (sometimes excessive) applications of nitrogen fertilizers have not only increased yields, but also permitted more extensive planting of cash crops, such as potatoes and peas and, to some extent, sugar beets.

By-products from processing of these cash crops provide cattle feeds which would otherwise become wastes from the agricultural processing industries. Hence, cattle feedlots utilize by-product feeds to supplement hay, straw, and silage (fermented green fodder).

Cattle feedlots are the most economical and efficient way to produce red meat to supply American dietary demands. It is logical, then, that the trend is toward even larger but fewer feedlots.

Locations of Pacific Northwest Feedlots

In the Pacific Northwest, cattle feedlots are concentrated in or near the irrigated farmlands in the arid or semiarid portions of Idaho, Oregon, and Washington--east of the Cascade Mountains. These irrigated farmlands and the fringing dry-farmed lands provide ruffage (hay, straw, silage) and feed grains in large quantity and the nutritious by-product feeds from processing of sugar beets, potatoes, and peas. The general locations of feedlots are as follows:

IDAHO: In the counties along the Snake River from Idaho Falls to Weiser.

OREGON: In Malheur, Jefferson, and Umatilla Counties in eastern Oregon, and in the Klamath Basin (Klamath County) in southern Oregon.

WASHINGTON: In the intensively irrigated middle and lower Yakima River Valley (Yakima County) and in the counties in and nearby to the Columbia Basin Irrigation Project--Douglas, Grant, Franklin, Adams, Walla Walla, and Whitman Counties.

In addition to wastewater runoff, there are other sources of water pollution from feedlots. Silage stored in large pits and feed scattered and lost on the ground is subject to leaching and washing to contribute organic constituents which demand oxygen for decomposition (the BOD requirement). Quantities of pesticides are used in dip pits and in spraying for insect control. The residue of these persistent synthetic organic pesticides can be carried from feedlots to pollute the surface waters. Dead animals are common in large feedlot operations, and if not hauled off promptly and disposed of properly, the carcasses become a source of disease which can be spread, even to nearby waters.

The principal source of water pollution is the huge accumulations of manure in the feedlots--34 cubic feet per animal per year. Water polluting wastes are leached and washed away as the manure decomposes. Scraping and mounding the manure to limit its areal coverage and to permit compaction does not prevent this leaching. Much of the water pollution from feedlots occurs in periods of rain and snow melt. Particularly significant is the runoff during the spring thaw. Although manure mounds are thawed, the pens are frozen hard immediately below the surface, so that runoff from snow melt and spring rain sluices the polluting wastes from the feedlot.

Water Pollutants from Feedlots

Runoff from feedlots contributes excessive quantities of nitrogen, phosphorus, and potassium to nearby rivers, lakes, and reservoir impoundments. These are nutrients contributing significantly to massive algal blooms (eutrophication). Nitrogen is mainly in the form of ammonia which is readily dissolved in water. Studies show that even airborne urinary ammonia is taken up by waters downwind of feedlots. Phosphorus, on the other hand, quickly combines with soil particles and is washed to drainageways through the erosion of disturbed surface soil in the feedlot.

High bacterial concentrations are always measured in feedlot runoff. Not only are the total coliform counts high (as much as 130,000,000 per 100 milliliter) but also pathogenic bacteria counts are high, particularly fecal streptococcus and others. Cattle feedlots are considered to be the principal source of high bacteria counts in the Snake River.

Bacterial contamination from feedlots is a public health hazard. The threat of waterborne disease organisms of animal origin is highlighted by the trend toward increasing numbers of animals in confinement along with the increase in outdoor, water-based recreation. The intestinal parasites can be transmitted to the water via animal feces and contracted by both humans and other animal life served by affected water bodies. Leptospirosis, salmonellosis and other forms of colitis, as well as other diseases affecting cattle and man may be transmitted from infected cattle by contaminated water. One investigator attributes 61 human cases of leptospirosis in the State of Washington to swimming in water contaminated by infected cattle. It should be noted that surface waterborne diseases (e.g. red water, black leg, and hoof rot) have caused cattle losses in some areas of Idaho and Oregon. Such diseases undoubtedly also endanger big game subject to exposure far downstream from feedlot concentrations.

High organic waste loads in combination with ammonia, phosphates, and potassium in feedlot runoff can adversely affect the biota of receiving streams by reducing the oxygen content and by the enhancement of conditions for noxious algae. As the organics decompose, the BOD requirement can reduce the dissolved oxygen to seriously low levels. Ammonia in the feedlot runoff is also known to be toxic to fish as well as cause of depletion of the dissolved oxygen in receiving streams, and may have contributed to fish kills in the Snake River.

Pesticides and other chemicals used in feeding operations, cattle dipping, and to control insect and odor problems constitute a constant threat to all biological life. These toxic, long-lived synthetic chemical pesticides are readily taken up and concentrated in the living organisms of the food chain in the streams receiving runoff from feedlots. Difficult as they are to control, pesticides must not be allowed to enter water courses. The necessary first step is proper application to eliminate excessive use of these chemicals, and the second is runoff control.

The Elements of Control of Feedlot Wastes

The first step in control of feedlot wastes is a change in viewpoint. Feedlot wastes must be considered not as wastes, but as natural resources capable of being recycled for beneficial use.

The ultimate goal in control of feedlot pollution is "A TOTAL SYSTEM APPROACH WHICH MEANS TOTAL RETENTION AND UTILIZATION OF ALL FEEDSTUFFS, MANURE, AND WATER AT THE LOT OR ON THE ADJACENT FARMLAND."

In simple terms, the answer to control of feedlot wastes is the return of wastes to the soil to replenish the supply of plant nutrients and to restore or improve the organic content of the soil in the production of feed recycled to the cattle in the feedlots.

The total system approach is the only practicable, economical method of preventing water pollution from cattle feedlot wastes. It is ecologically and economically sound, because it involves recycling of all organic wastes--from cattle feed to beef to fertilizer for feed crops and back to beef. Under this approach wastes are recycled to beef through feed crops, and, in the process, potential water pollutants from cattle feedlots are prevented from reaching our streams and rivers.

A total system approach includes three major components:

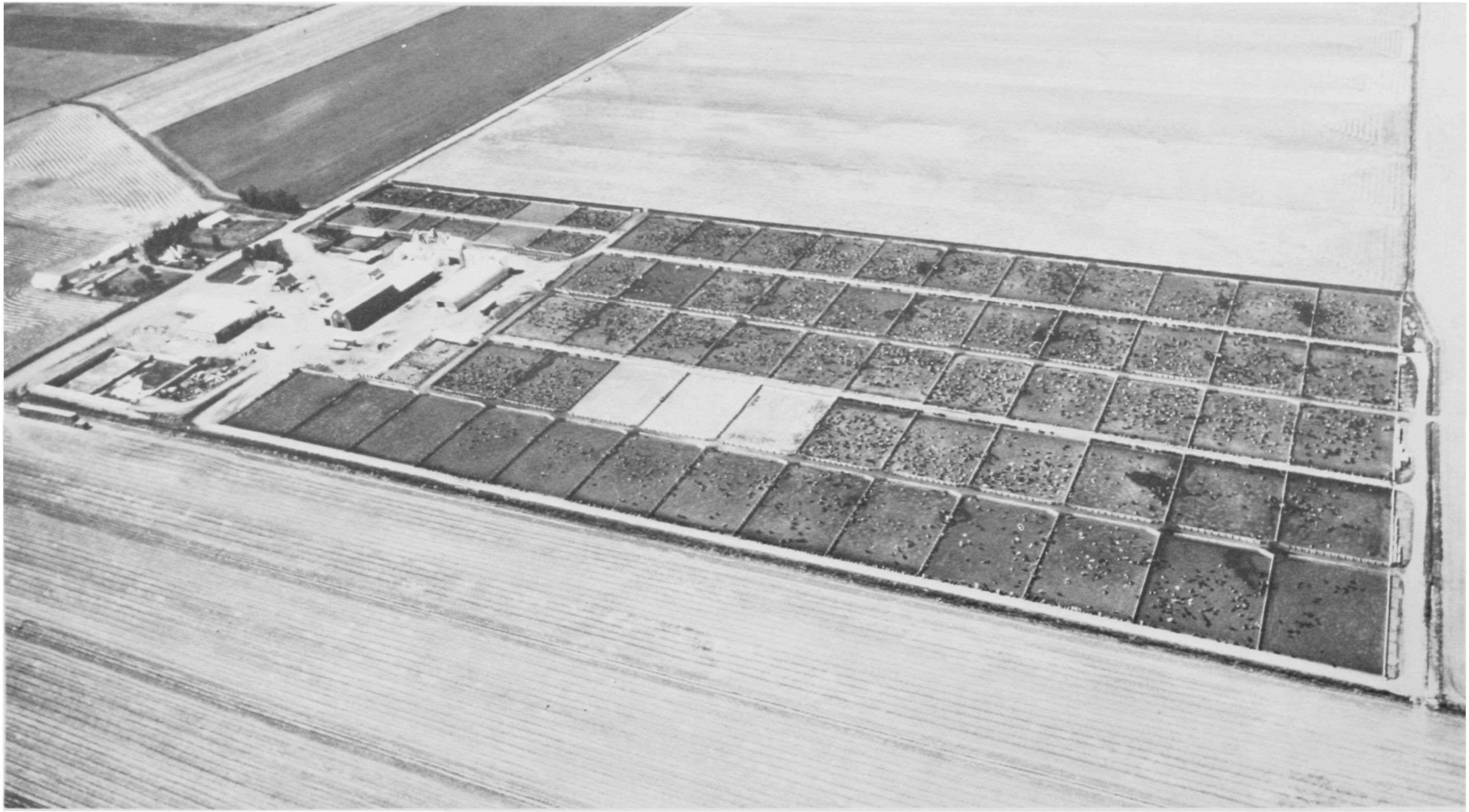
Proper site selection

Proper feedlot design

Proper feedlot management

The three succeeding chapters are devoted to a discussion of each of these basic components. They contain guidelines providing general information to aid in the location, design and operation of cattle feedlots to minimize the threat of water pollution.

Poorly located and inadequately designed and operated feedlot on the Snake River in western Idaho. This operation should be relocated.



A well located and designed feedlot operation in eastern Idaho. Natural runoff is diverted around the operation by irrigation dikes, however, feed pen runoff does enter the irrigation system during spring breakup. A feed pen runoff collection and lagoon system should be provided for land disposal of the collected wastes.

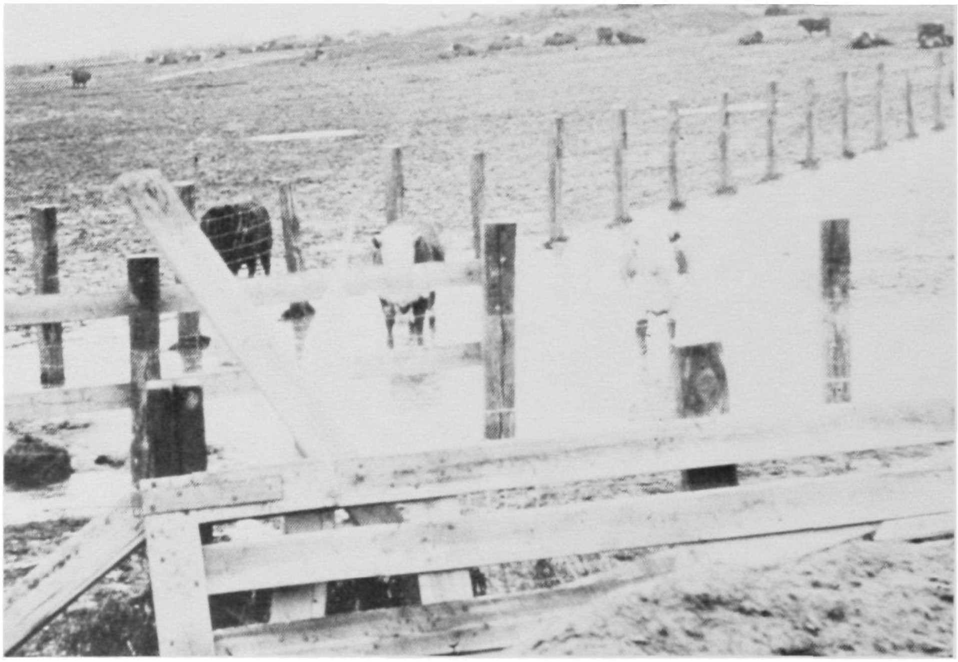
Mill Creek washing "shud" from a small unfenced lot in eastern Washington. Unfenced lots without a green belt are poor operations and should be discontinued.

Partially fenced feedlot with no green belt or dikes provided for protection during high water. A pen runoff collection and treatment system should also be provided to protect water quality in the Payette River and irrigation canal.

Undiverted natural runoff and uncollected cattle feedlot drainage in western Idaho.

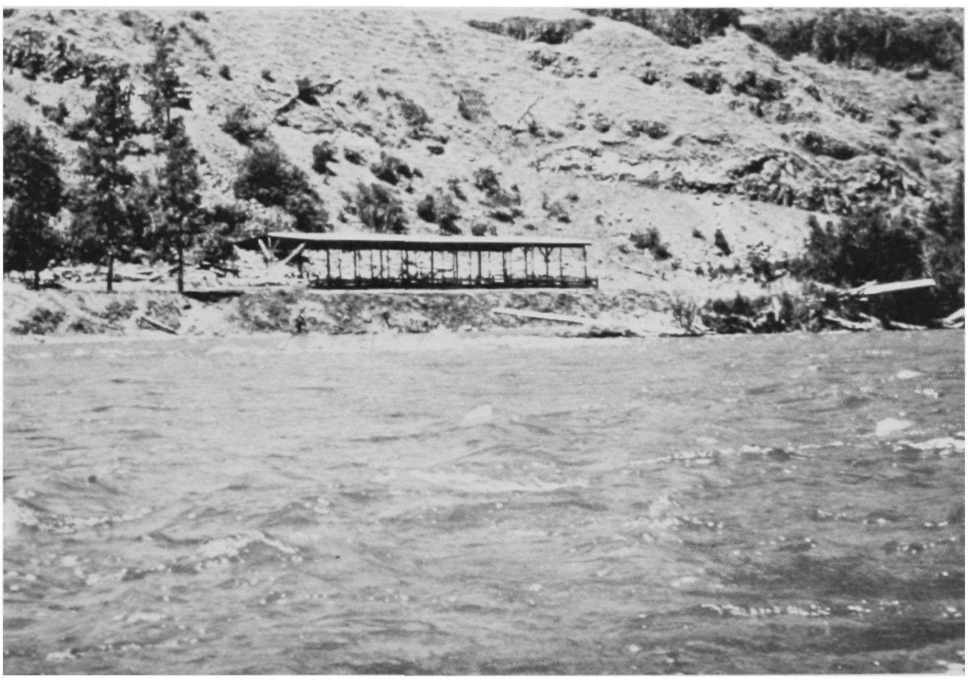
Fenced and uncollected pen drainings which drain to a small waste way and to the Yakima River.

Unfenced and undiked feed pens on bank of Snake River above Asotin, Washington. For proper operations a green belt, fence, and dike should be provided and/or installed above the high water elevation of the river.



Uncontrolled feedlot and natural runoff through a feedlot in eastern Washington.

Watering troughs discharge which drains to Wild Horse Creek in eastern Washington.



Unfenced lot and covered feed bunker on Grande Ronde River. Pen scrapings are shoveled onto the river bank and washed away by rising flood waters.

Unconfined, unfenced feeding operation on bank of Grande Ronde River.

Feedlot and natural uncontrolled runoff through feedlot in eastern Washington.

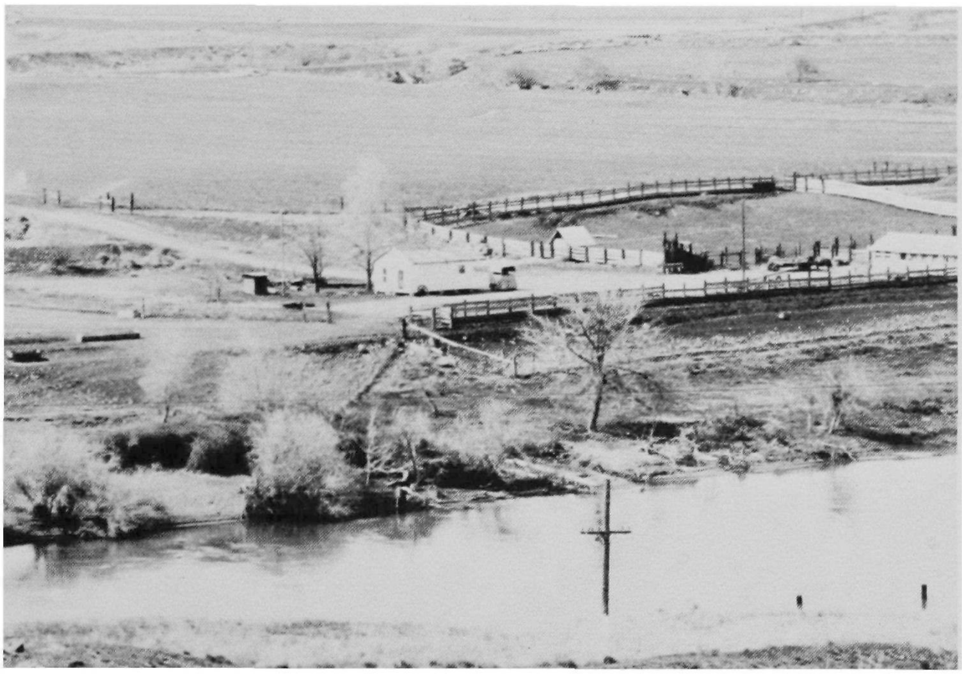
Dead cow on west bank of Snake River below the mouth of the Grande Ronde River.

Feedlot with no runoff control on bank of Snake River at Burley, Idaho.

Improperly located and designed feedlot in western Idaho. To be properly operated at the present site facilities should be provided for a wider green belt with a runoff and lagoon system of waste treatment.

Good location away from stream near Weiser, Idaho.

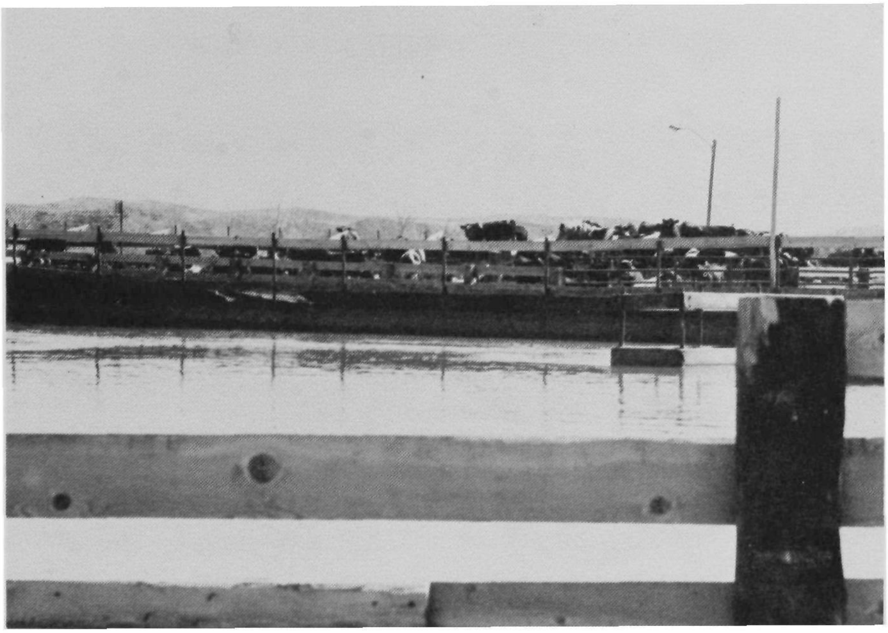
Unfenced bull pen on bank of Snake River near Menan, Idaho.



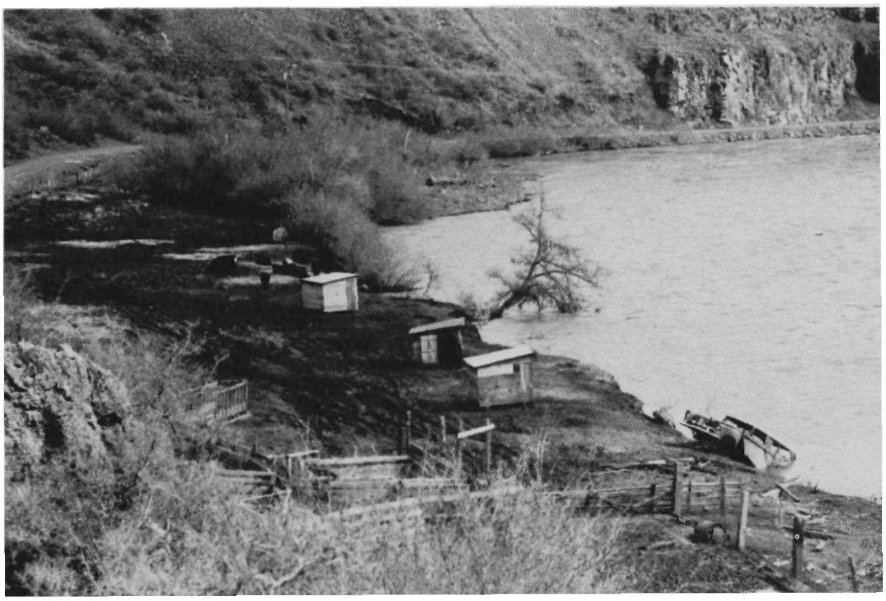
Partially unfenced feedlot on bank of Yakima River.

New cattle feedlot properly located, designed, constructed, and operated.

Undiverted natural runoff and feedlot drainage being collected by a major railroad fill near the Columbia River in south central Washington. A proper feed pen runoff collection and lagoon system should be provided.



Uncleaned feed pens being inundated by rising flood waters of the Snake River in southwestern Idaho.



Unconfined, unfenced cattle feeding operations on Grande Ronde River above Washington State Highway 129 bridge. Fences and a greenbelt should be provided for the protection of water quality and the fishing public.

Cattle feedlot lagoon effluent ditch used to transport effluent onto green pasture on sandy soil in southwestern Idaho.

An example of an improperly located feedlot in southeastern Washington. Natural runoff and feedlot drainage from this operation as well as "shud" erosion caused by rising flooding river water cause water quality degradation and create a public health hazard to water oriented sports.

CATTLE FEEDLOT SITE SELECTION

The site selected for the location of a cattle feedlot is the most important factor in minimizing the threat of water pollution. With proper site selection, construction and operating costs may often be reduced by the elimination of the need for certain pollution control facilities and practices.

The aim in feedlot site selection is to locate in areas where a total system approach can be developed. Such a system should include the complete containment of wastes for recycling to cropland and ultimately back to feed animals.

Guidelines for Site Selection

1. All cattle feedlots should be located outside of the 10-year flood plain of all river systems. If the 10-year flood plain of stream is unknown, all feedlots should be located at least 100 yards outside of the apparent flood plain or high water marks of the stream.

2. If a cattle feedlot is to be located near a lake or reservoir, it should be situated downwind and at least 100 yards outside of the lake's apparent high water line or the reservoir's 25-year flood pool elevation.

3. Cattle feedlots should be located at least 100 yards away from any intermittent dry storm drainage gulley or irrigation drainage ditches.

4. Cattle feedlots should be located at least 50 yards away from any irrigation supply canal.

5. Ideally, unpaved uncovered feedlots should be constructed on a site having at least a 30-foot soil mantle between the maximum groundwater table elevation and the feedlot surface. In cases where such a depth of soil is not available, the State Department of Geology or an extension agent should be contacted to determine if the site is suitable.

6. All uncovered or partially covered feedlots should be located in arid or semiarid areas to allow for efficient recycling of wastes.

7. For odor control cattle feedlots should not be constructed adjacent to any community. If a feedlot is to be constructed in the vicinity of a community, it should be located at least one mile downwind.

8. Feedlot sites for uncovered feeding operations should be uniformly sloped at approximately 2-8 percent to provide adequate surface drainage.

9. Feedlot sites should be so situated as to minimize or eliminate any storm water from running onto or through the feedlot operation from adjacent land.

CATTLE FEEDLOT DESIGN

The design of a cattle feedlot must include systems for the retention of all wastes on the premises until their ultimate disposal. This includes the retention of manure, liquid waste and runoff from the feedlot area.

General Design Guidelines

1. The first logical step in a pollution control program around a feedlot is to prevent the waters not falling on the lot from flowing across the lot. Water falling outside the lot area should be diverted around a feedlot and kept separate from feedlot drainage. This measure will minimize the size of collection and treatment facilities as well as decrease the cost of waste water handling and treatment.

2. All feedlots should have holding ponds for retaining liquid wastes and runoff on the premises. Two or more ponds in series are desirable. The first pond serves as a settling basin and the remainder serve as liquid storage lagoons. In areas underlain with permeable sand and gravel or porous lava, holding ponds should be adequately sealed to prevent leakage and groundwater pollution. In general, seepage through the pond bottoms and sides must not exceed one-fourth inch of pond surface level per day.

3. All feedpens should be sloped down and away from the feeding area to provide for the movement and collection of runoff.

4. Drain ditches should be located along the back of each feedpen to carry liquid wastes and runoff to the holding ponds. The ditches should be designed to carry the solids in suspension.

5. Adequate portable pumping equipment should be available for de-watering the holding ponds so that emergency detention capacity can be provided. Pumping capacity should be sufficient to drain the ponds in a five-day period.

6. Silage storage areas should be constructed with sufficient drains so that all liquid wastes will drain into the holding ponds. The runoff liquids from silage pits are saturated with cellulose compounds and are extremely difficult to break down. These compounds in the liquids make a heavy demand on the available oxygen supply in watercourses and must therefore be totally confined to the farm operation.

In addition to these general considerations, the feedlot operator must be aware that his waste management system may require additional protective facilities not covered herein. The design of these facilities may require the services of consulting specialists such as consulting engineers, local Extension Representatives, Soil Conservation Service (SCS), the State Department of Health or other appropriate agencies.

The SCS and the State Extension Service provide engineering assistance to those operators who need help in designing their waste management systems.

Federal cost-sharing programs relating to pollution abatement are also available to the feedlot operators. The Rural Environmental Assistance Program (REAP) administered by the Department of Agriculture has the authority to provide Federal cost-sharing of pollution abatement costs for such facilities as lagoons, diversions and other waste or runoff management practices.

Local agricultural extension agents will provide valuable assistance to the operator regarding the application rates of cattle waste on agricultural land.

Feedlot Layout and Design Guidelines

The second major component of a total system approach is the layout and design of the feedlot operation. There are two basic feedlot layouts, covered and uncovered, and each has its particular pollution control methods.

In developing the following feedlot layout guidelines, an attempt has been made to provide a layout which not only would meet the previously mentioned water pollution control measures but at the same time provide cattle feeding and loafing areas conducive to maximum weight gains.

Uncovered Feedlots

In an uncovered feedlot operation, all surface runoff from the entire operation must be retained upon the site of the feedlot operation. In addition, any surface runoff from the land surrounding the operation must not enter on or pass through the feedlot operation.

Uncovered, unpaved (excluding feed bunk aprons) feedpens should have a slope of approximately 2-8 percent sloping away from the feed bunks. This degree of slope should provide adequate surface drainage of the pens. A surface drainage collection ditch should be located adjacent and parallel to the cattle alley. The slope of these collection ditches should be about one percent and the collection ditches should extend the length of the cattle alley, if practical, and discharge into a retention lagoon.

Cattle alleys with feedpens located on each side should be provided with separate drainage ditches for each series of pens to minimize the number of runoff crossings.

Uncovered, paved feedpens should be similar in all respects to the uncovered unpaved feedlots with the exception of the degree of slope of the feedpen surface. The slope for the paved lot should be approximately 0.5-1 percent.

Feedpens can be designed with slotted floors to automate, to some degree, the removal of manure. It should be noted that some feedlot operators have experienced excessive animal mortalities with slotted floor designs. Before designing such a layout the operator should consult with the local Extension Agent.

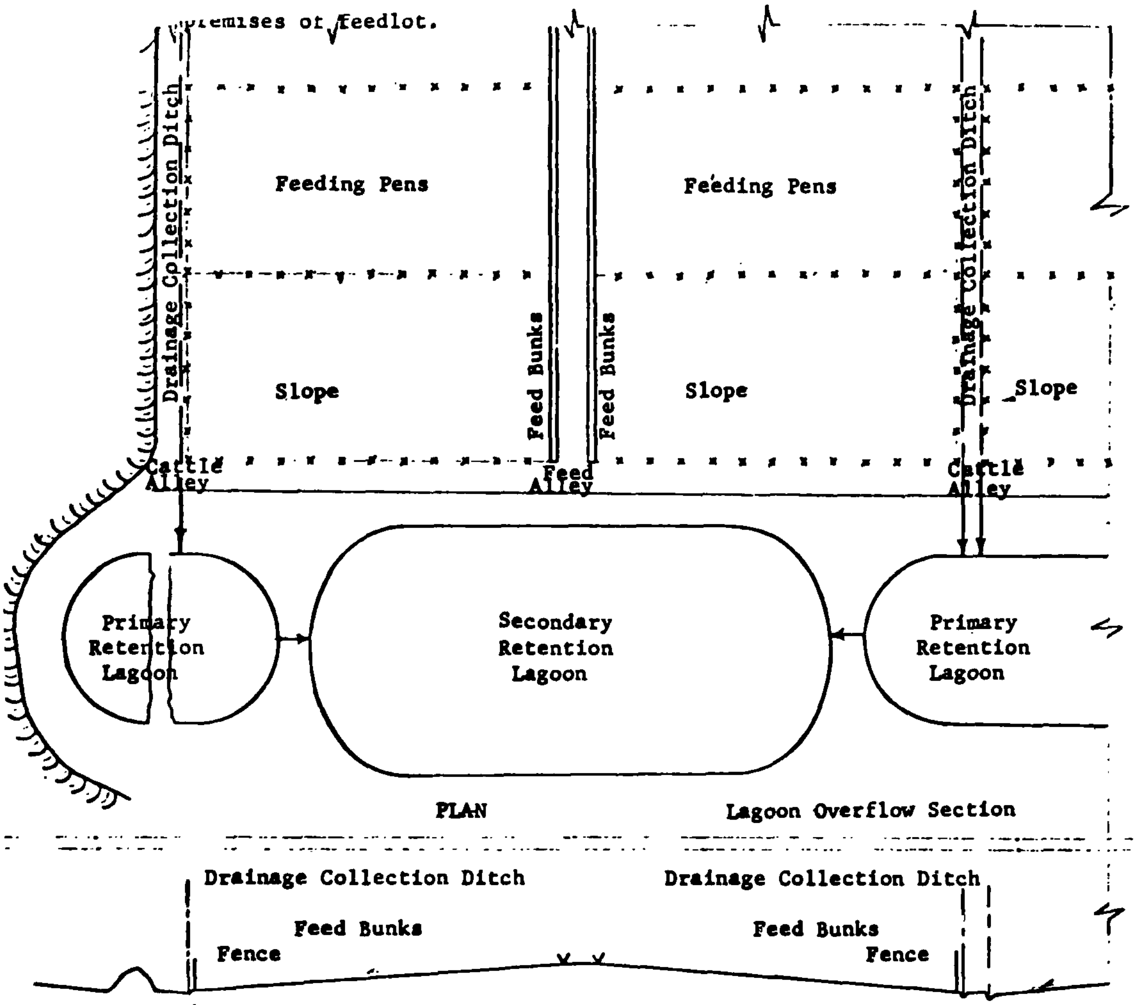


FIGURE NO. 1

TYPICAL FEEDING PEN LAYOUT
UNCOVERED, PAVED AND UNPAVED
FEEDLOT OPERATION

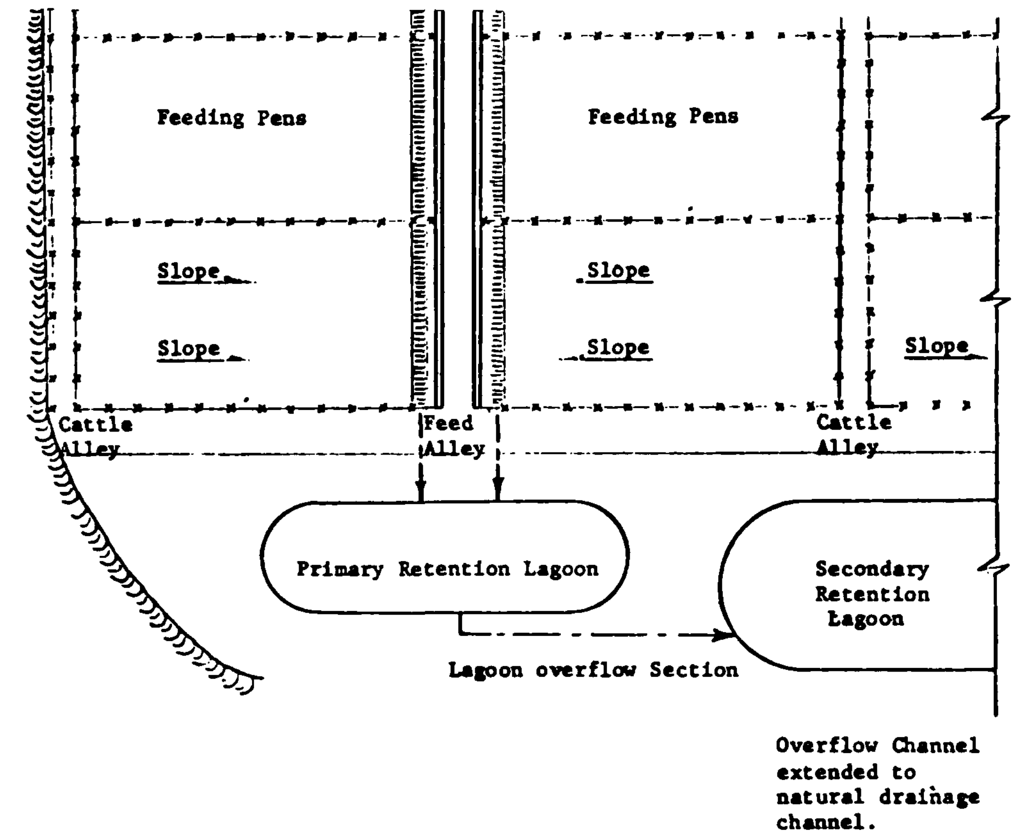


FIGURE NO. 2

TYPICAL FEEDING PEN LAYOUT: SLOTTED FLOOR SOLIDS WASTE MANAGEMENT SYSTEM, UNCOVERED, PAVED AND UNPAVED.
FEEDLOT OPERATION

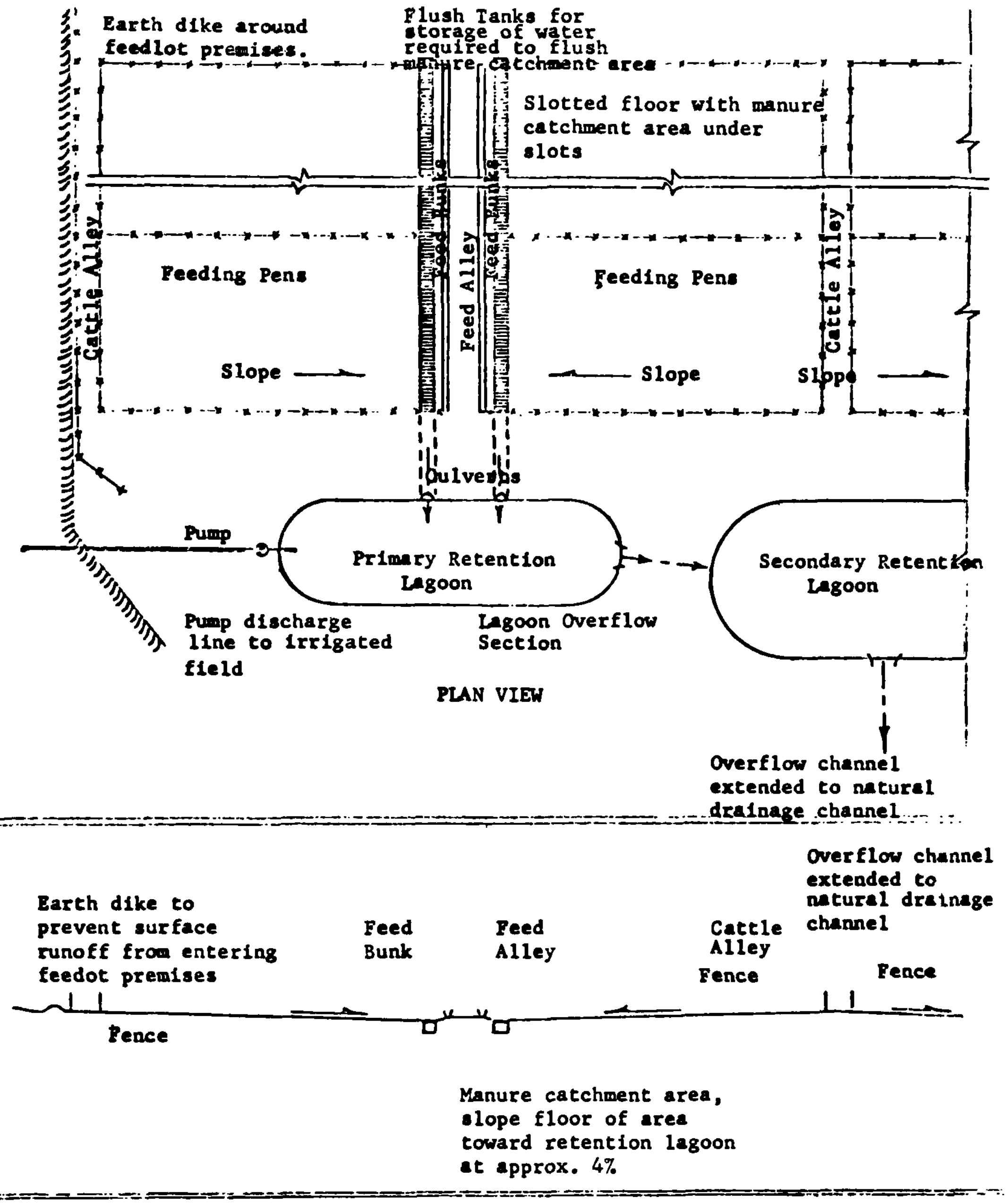


FIGURE NO. 3

TYPICAL FEEDING PEN LAYOUT
LIQUID WASTE MANAGEMENT SYSTEM (FLUSH TYPE)
SLOTTED FLOOR, UNCOVERED, PAVED AND UNPAVED
FEEDLOT OPERATION

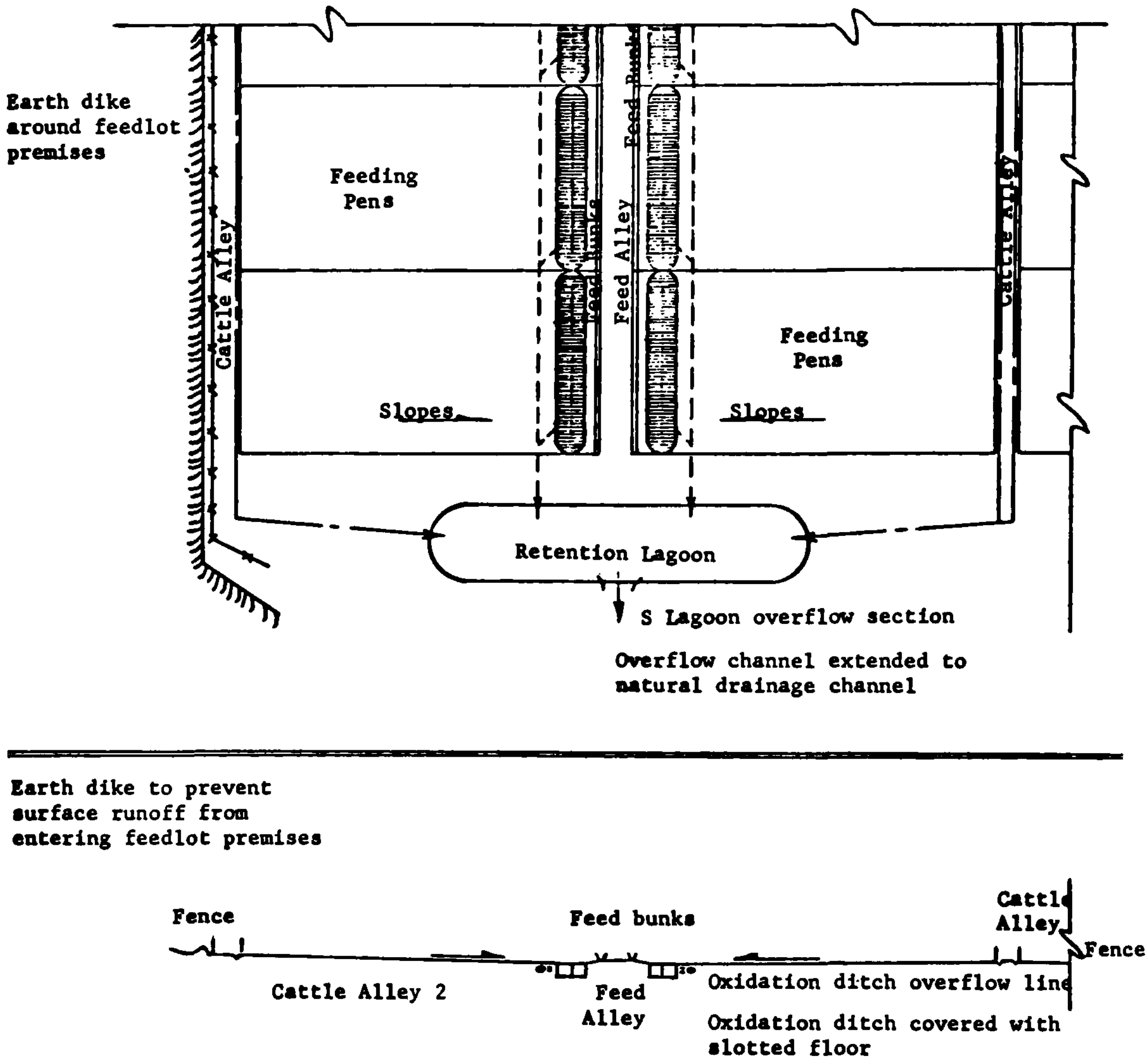


FIGURE NO. 4

TYPICAL FEEDING PEN LAYOUT
LIQUID WASTE MANAGEMENT SYSTEM (OXIDATION DITCH TYPE)
SLOTTED FLOOR, UNCOVERED, PAVED AND UNPAVED
FEEDLOT OPERATION

Uncovered feedpens with partially slotted floors which are designed to gather and dispose of the manure in the solid state, should have the unslotted portion of the pens sloped toward the slotted portion at a slope of 3-5 percent for unpaved lots and 0.5-1 percent for the paved lots. The major axis of the slotted floor area should run parallel to the feed alley. The manure and storm runoff catchment area under the slotted floor should be sloped at approximately 0.5-1 percent (assuming catchment area is paved) and should be sloped in a direction parallel to the feed alley. In essence, these catchment areas become the surface drainage collection ditches during storm periods. Therefore, each series of catchment areas should discharge into a retention lagoon.

To facilitate removal of the manure which accumulates under the slotted floors, an on-site removable and retractable mechanical scraping device should be designed to scrape the manure out from under the slotted floors and into an open area from which the manure can be disposed.

Uncovered feedpens with partially slotted floors which are designed to gather and dispose of the manure in the liquid state may be of two basic types, the flush or oxidation ditch systems.

In the flush type system that basic design would be similar to slotted floor designed to handle the manure in a solid state with the exception that the slope of the paved catchment area in the direction of its length should be about four percent and the length of the catchment area would be restricted due to flushing water requirements. A retention lagoon would be required to hold the flushing water, plus storm runoff. This system has the disadvantage of year-round disposal of the liquid waste which in many instances would be impossible without causing a surface water pollution problem.

The oxidation ditch type system consists of a closed racetrack-shaped manure catchment area located under the slotted floor. This racetrack-shaped catchment area is initially filled with water and manure to some predetermined depth (approximately two feet). The mixture of the water and manure is then continuously circulated and aerated by a rotating paddle wheel.

The feedpens should be sloped toward the slotted floor in the same manner as the slotted floor operations having a dry manure handling system. An overflow drain line should be provided to prevent submergence of the paddle wheel as a result of storm runoff. The drain lines should discharge into a retention lagoon.

Covered Feedlots

Covered, paved or unpaved feedpens not including slotted floors must meet all the water pollution control requirements stated earlier.

In a covered or partially covered feedlot, the operator may decide to retain all the surface runoff as spelled out for the

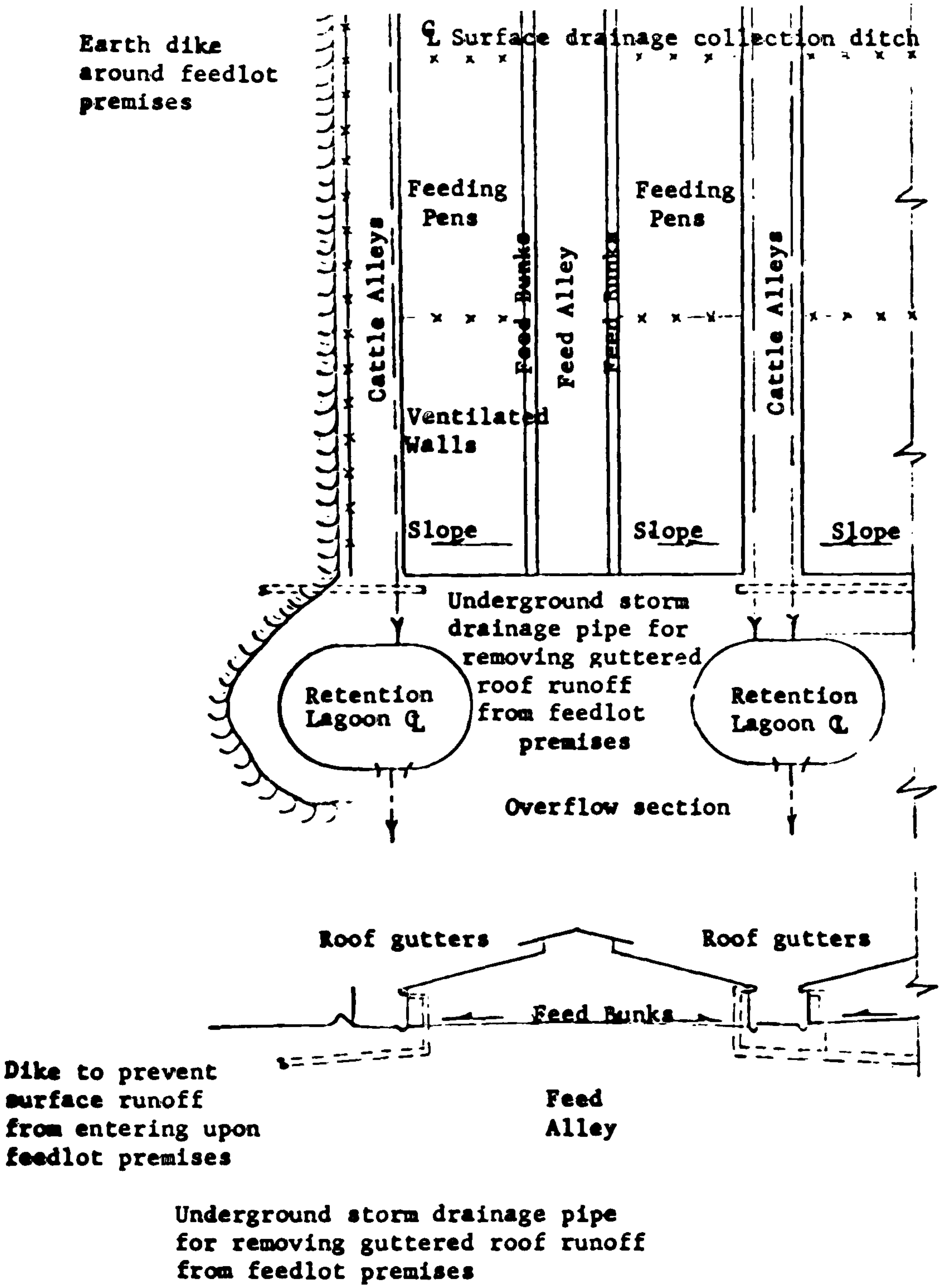


FIGURE NO. 5
TYPICAL FEEDING PEN LAYOUT
SOLID WASTE MANAGEMENT SYSTEM
COVERED, PAVED AND UNPAVED
FEEDLOT OPERATION

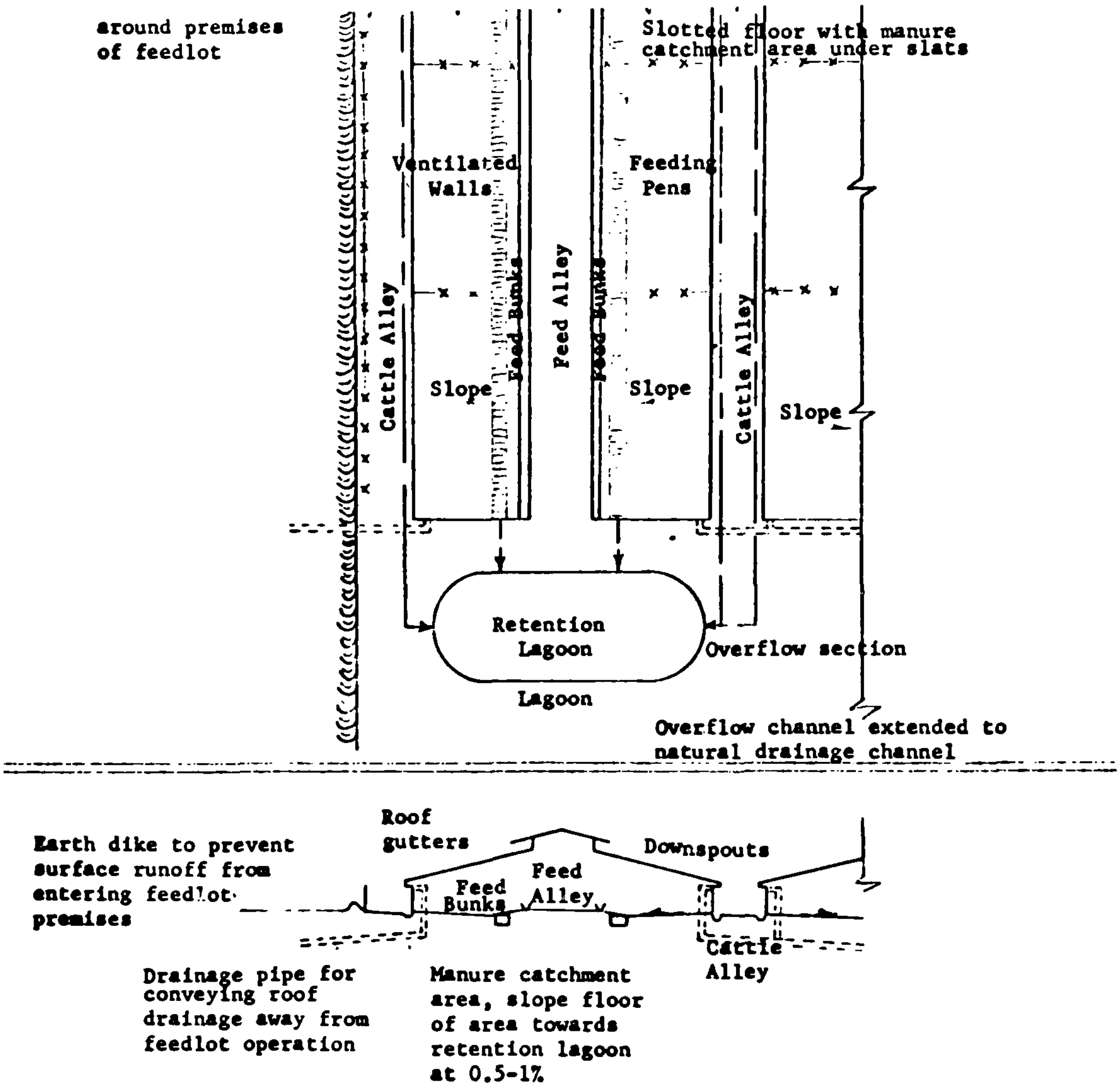
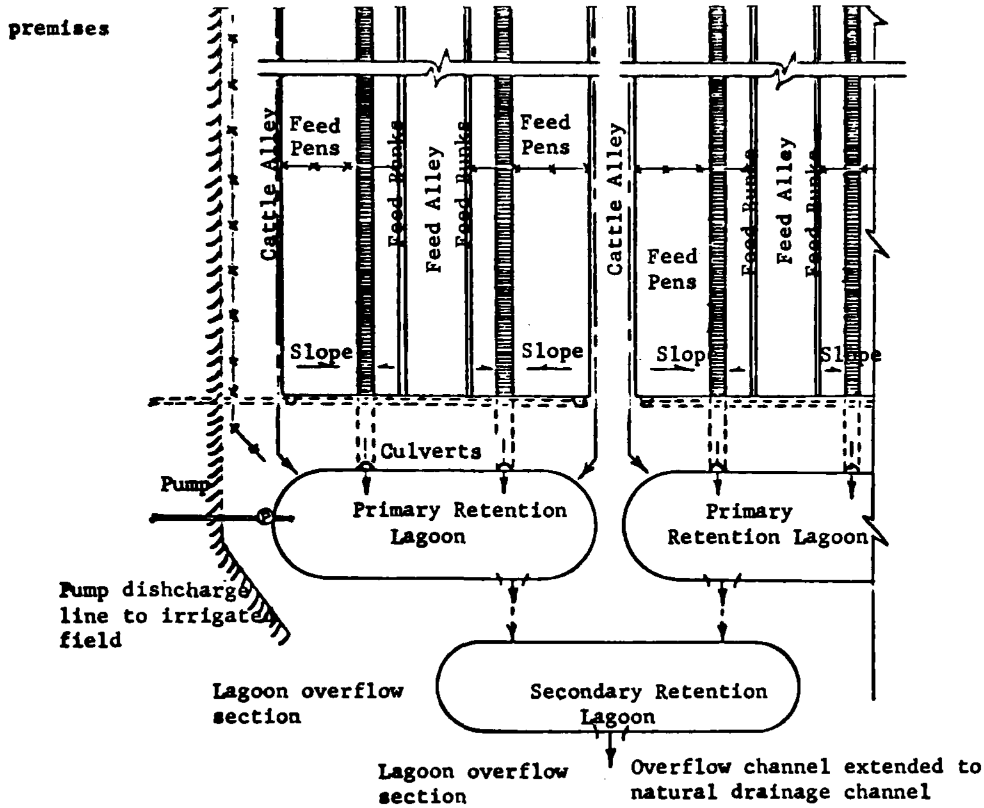


FIGURE NO. 6

SOLID WASTE MANAGEMENT SYSTEM
TYPICAL FEEDING PEN LAYOUT
SLOTTED FLOOR, COVERED, PAVED AND UNPAVED
FEEDLOT OPERATION



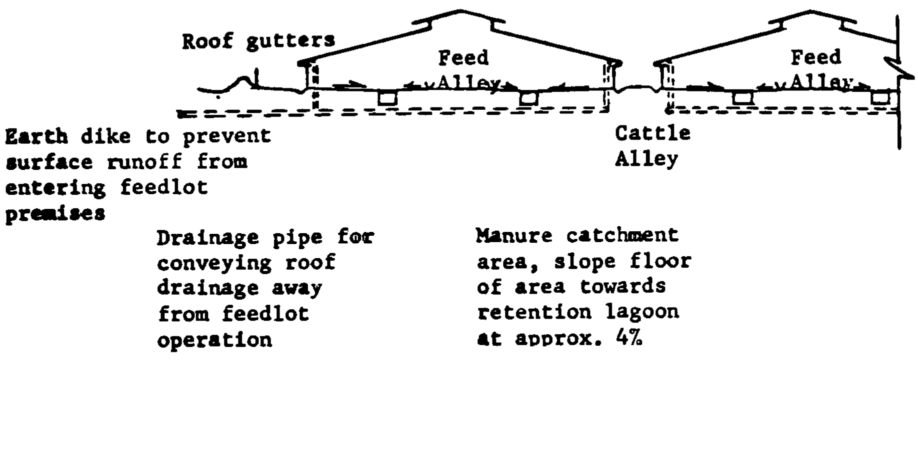


FIGURE NO. 7
TYPICAL FEEDING PEN LAYOUT
LIQUID WASTE MANAGEMENT SYSTEM (FLUSH TYPE)
SLOTTED FLOOR, COVERED; PAVED AND UNPAVED
FEEDLOT OPERATION

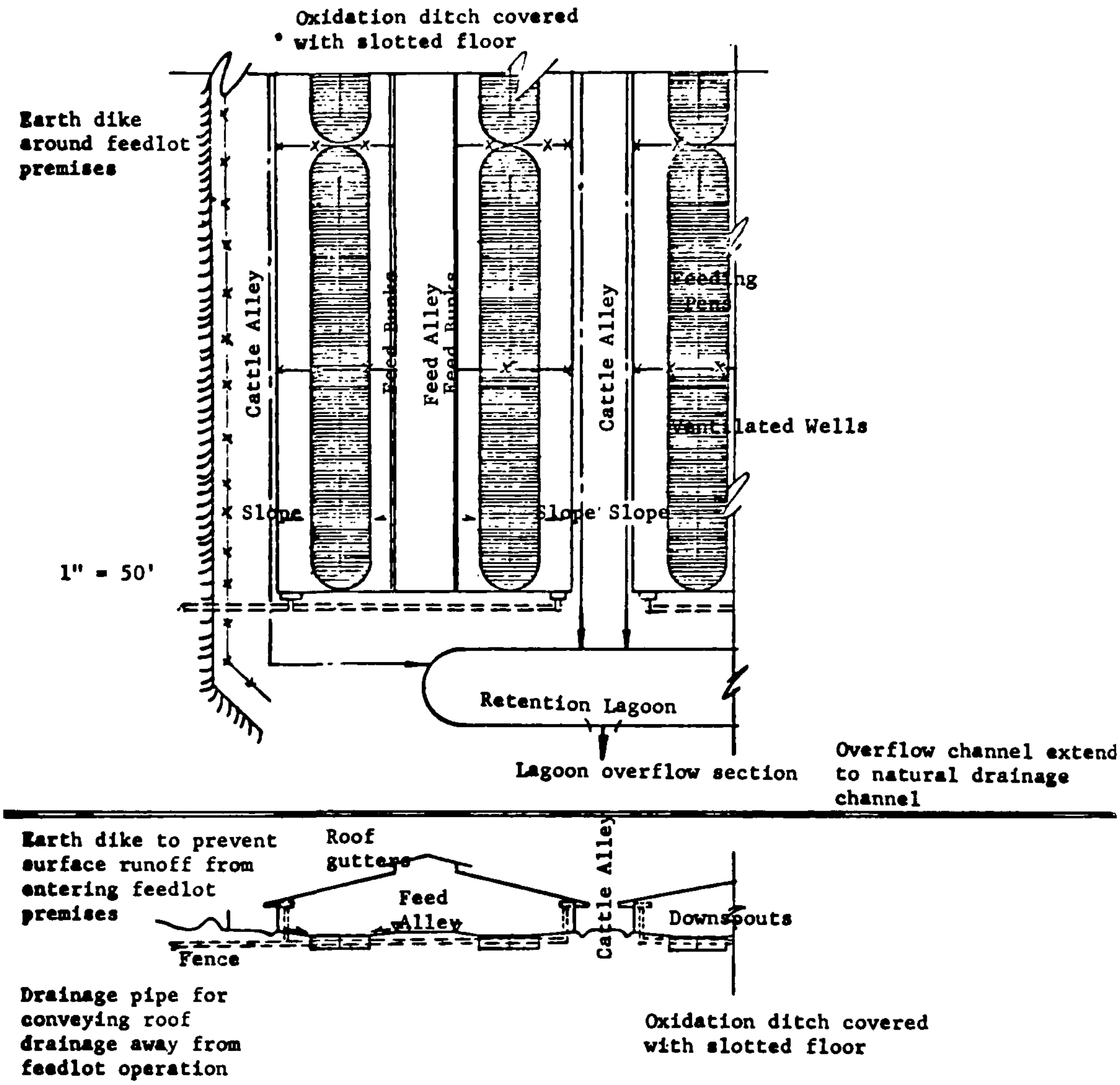


FIGURE NO. 8
TYPICAL FEEDING PEN LAYOUT
LIQUID WASTE MANAGEMENT SYSTEM (OXIDATION DITCH TYPE)
SLOTTED FLOOR, COVERED, PAVED AND UNPAVED
FEEDLOT OPERATION

uncovered feedlots. However, to minimize the size of the retention lagoon he should select to gutter all roofed areas. The water thus collected should be conveyed through underground piping to an area outside and downslope of the feedlot operation. The gutters and underground piping must be designed to carry the average 10 year, 24 hour rainfall or design storm (see appendix). All uncovered portions of the operations must conform to the same conditions as set forth for uncovered feedlot operations. As with the uncovered feedlot operations, any surface runoff from land surrounding the operation must not enter on or pass through the feedlot operation.

Concentrations of cattle are normally considerably higher in covered operations which requires systematic removal of manure if optimum weight gains are to be obtained. Therefore, an area must be provided to stockpile this removed manure. The manure stockpile area probably would be uncovered. Any surface drainage from the stockpile area as well as the other uncovered areas including any surface drainage from the covered feedpens must be retained in a retention lagoon.

Covered feedpens with partially slotted floors, designed to handle the manure in a solid state, should be laid out similar to their counterpart in the uncovered slotted floor operations. The primary difference will be in the slope of the lot toward the slotted floor and the size of the retention lagoon. The slope of the lot may be reduced to that required so that the cattle will walk the manure into the catchment area located under the slotted floor (0.5-1 percent for paved and 1-2 percent for unpaved). In addition, the retention lagoon will be appreciably smaller as a result of the roof gutters bypassing the storm runoff from the feedlot surface.

Covered feedpens with partially slotted floors which are designed to handle the manure in a liquid state should be laid out similar to their counterpart in the uncovered slotted floor operations. The primary differences between the flush type and the oxidation ditch type systems is the degree of slope of the feedlot surface towards the slotted floor area and the capacity of the retention lagoons.

Each feedlot operation is a unique situation. The design and layout should be tailored to the site and to the particular feeding operations anticipated. Whether covered, uncovered, or a combination, the design objective is to retain wastes on the operation.

FEEDLOT WASTE MANAGEMENT

Manure and other sources of waste associated with cattle feeding operation must be managed so as to prevent surface or groundwater pollution problem. Current economic conditions of the cattle feeding industry and the existing waste treatment technology yields little hope for the feedlot operator to treat his operation waste sources to such an extent that they would be of adequate quality for discharging into a surface or subsurface water body.

Waste Management Guidelines

1. Manure mounds should be formed in the dry season. During the wet season, the mounds can be scraped clean of wet manure to provide a dry area for the cattle to rest. The wet scrapings should be removed from the mound area for ultimate land disposal.

2. When it is necessary to remove manure from the feedpen area and immediate land disposal is impossible, it should be stockpiled. Drainage from manure stockpile areas should be routed to the holding ponds.

3. The liquid waste contents of holding ponds should be discharged to the disposal area as frequently as possible so as to provide storage capacity in the ponds.

4. Overflow from water troughs should be discharged outside the feedlot area through a pipe system.

5. Manure from feedlots other than partially slotted floor operations should be removed as required to insure a maximum gain in the fed cattle. Odor, dust, and fly propagation must at the same time be controlled. In slotted floor operation the manure is removed from the feedlot surface continuously as a result of the cattle moving around inside the feeding pen.

6. A current acceptable waste management practice for uncovered unpaved feedlots is to form manure mounds during the dry season to heights of 8 to 12 feet. During the wet season the surfaces of the mounds are scraped clean of wet manure to provide a dry area for the cattle to rest and sleep. The wet scrapings are pulled into the low areas of the feeding pen. During the subsequent dry season the mounds are reformed, at which time any excess manure is removed from the pen.

7. The manure catchment area under slotted floors designed for dry handling of the manure should be cleaned on a routine basis, and the manure should be either stockpiled on the feedlot premise for later disposal or, if the conditions are appropriate, the manure should be hauled directly to its ultimate disposal area.

8. Feeding operations having slotted floors with flush type liquid waste handling systems require retention lagoons designed and constructed to contain a month's supply of the flush water plus the design storm runoff from the remainder of the uncovered portions of the feedlot (separate lagoon may be used). The lagoon contents

must be discharged as early as possible to provide capacity for possible future storm runoff.

9. Slotted floor feeding operations with oxidation ditch manure handling systems require little management with the exception of routine maintenance on the paddle wheel drive train. During normal operations, at least one foot of water should cover all settle solids to insure odor and fly control. Annually, during the fall of the year, the oxidation ditch should be cleaned of its contents for ultimate disposal. Overflow lines from the oxidation ditch to the retention lagoons should be inspected periodically to insure that they are not plugged.

10. If it is required to remove manure from the feeding area when conditions are adverse for its ultimate disposal, the manure should be stockpiled on the feedlot premise. Any runoff from this stockpile must be retained upon the feedlot surface. If a feedlot operation is located in a high groundwater area, a paved area should be provided for stockpiling the excess manure. In most cattle feeding areas a stockpile area sufficient to hold a six-month production of manure should be adequate.

11. Dead animals, rodents, etc. and waste pesticides should be retained upon the feedlot premise until they can be disposed of in such a manner as will not cause a water pollution problem.

12. To assist in controlling the dust problem which occurs at unpaved feedlots during extended dry periods, the operator

should increase the concentration of cattle to the maximum extent possible without detrimentally affecting cattle weight gains. If this does not curtail the problem, spraying of the feedlot surface with water may be required.

13. Reproduction of flies should, to the extent possible, be controlled by attempting to keep the manure well dried during fly propagation periods. If inadequate ventilation, climate condition or water spraying for dust control limits the drying of the manure during fly propagation periods, the manure should be sprayed with a suitable pesticide. Retention lagoons should also be sprayed for fly control during propagation periods.

14. Odor control is at times a serious problem with cattle feedlot operations. The odor generates from the anaerobic decomposition of manure which usually occurs on the inside of moist manure piles. When these piles are disturbed, the odors from anaerobic decomposition are extremely severe. The solution of the problem is not an easy one due to other restrictions for preventing water pollution. Masking the odor with a chemical may be possible. However, the odor could be minimized by attempting to keep the manure pack dry and only disturb the manure piles when wind conditions will transfer the odor away from nearby populated areas.

Waste Disposal Guidelines

Land disposal is currently the only industry-wide acceptable method for the disposal of cattle feedlot wastes. An exception is dead animals which should be disposed of at rendering or animal by-products plants. The recommended method for disposing of manure and associated wastes is spreading upon and incorporating these into agricultural land.

The following guides are divided into two groups. The first being guides for the disposal of dry manure and other waste solids, and the second being guides for disposal of liquid waste.

Disposal of Dry Manure and Other Solid Waste by Spreading on Agricultural Land

1. Dry manure should be spread on annual crop lands either immediately prior to planting or immediately following harvest. In either case, the manure should be incorporated into the soil mantle by cultivation soon after spreading.

2. Since manure cannot be incorporated into the soil mantle when the manure is spread on irrigated pasture or alfalfa lands, special provisions should be made to retain and reuse all of the irrigation tail water which drains off the irrigated fields during irrigation of the field with the liquid waste and that which drains the next few days after irrigation.

3. Land requirements for dry manure disposal should be determined on the basis of soil conditions, crops, and local climatic conditions. These factors should be determined in consultation with the extension agent.

Disposal of Liquid Waste

1. Liquid manure retained in lagoons or oxidation ditches should be disposed of by spreading the waste upon agricultural land. If the liquid is sprayed or allowed to flow by gravity onto the land it should be applied at a quantity equivalent to the depleted soil moisture. Under no condition should the waste be applied upon a frozen or saturated field unless facilities such as dikes or berms are provided to prevent runoff from the field.

2. Special provisions must be provided to retain and reuse any tail water drainage which results from the field being irrigated during and subsequent to irrigation with the waste liquid.

3. Disposal of waste pesticides must be done in accordance with state regulations; therefore, dip pit wastes or any other pesticides used in conjunction with feedlot operation must be given special consideration.

General Land Disposal Considerations

The nutrient and soil requirements for specific crops grown in various areas of the state can be obtained from the Department of Agriculture. In general, high volume crops such as hay, green pasture crops and grasses or corn will remove large amount of nutrients from the soil; therefore, higher application rates can be used on each acre where these crops are raised. Alfalfa, a deep-rooted crop, may prevent much of the nitrate leached below the root zones of previous rotations of shallow-rooted crops from reaching the water table.

In order to adequately protect the groundwater quality in the land disposal areas, approximately 250 pounds of nitrogen per acre per year (equivalent to the annual waste from five beef cattle) can be applied to forage or pasture. The application rate of liquid waste from the retention ponds is equivalent to waste produced by six beef cattle provided that tight soil conditions exist. This rate would be excessive when applied to sandy soils.

Greater application rates can be applied to the land if, in the opinion of the State Department of Health or other appropriate agency, the surface and groundwaters in the vicinity of the disposal area are not adversely affected by these higher rates. In areas where no surface or groundwater pollution is possible, the equivalent waste produced by 50 beef cattle can be applied to each acre of disposal land. However, in some cases this rate may be excessive due to the high potential for salt build up in the soil.

In areas with annual rainfall greater than 30 inches, manure applied to the land should be incorporated into the soil mantle as soon as possible to eliminate runoff from the disposal area. In this area more land will have to be made available for liquid waste disposal since the land will be saturated longer during the year. Holding dikes or berms should be constructed to prevent runoff.

APPENDIX

Four equations are included in this appendix to aid in the calculation of (1) short term retention of runoff from feedlots, (2) minimal surface areas for evaporation ponds, (3) volume of evaporation ponds, and (4) depth determination of evaporation ponds. Figures F-1, F-2, and F-3 are "area identification" for applicable drainage basins in the States of Idaho, Oregon, and Washington respectively. Table 1-T, General Monthly Precipitation and Pan Evaporation, provides information needed for the above equations. Table 2-T presents soil characteristics in cattle feeding areas. Column 1, "Basin Number" from both tables should be coordinated with the appropriate Figure F-1, F-2, or F-3.

Short Term Facilities

The magnitude of runoff is a function of the amount of precipitation falling on the lot and that fraction which is not retained on the feedlot as ponded or absorbed water. The capacity of short term collection facilities should be based upon the runoff resulting from a 10-year, 24-hour rainfall intensity (design storm). Average 10-year, 24-hour rainfall intensity curves are shown on Figure 1-T.

The total volume required for short term retention of runoff from the feedlot area can be determined by the equation:

$$V = 0.083 \text{ (feet/inch)} \times A \text{ (acres)} \times I \text{ (inches)} \times C \qquad \text{EQ.1}$$

where:

V = Total volume of runoff in acre-feet.

A = Total drainage area of feedlot and pond in acres.

I = Design rainfall intensity in inches (From Figure 1-T).

C = Runoff coefficient. Use 0.93 for most cases. This value is based upon the assumption that 7 percent of the short term runoff is retained either on the surface pack or in puddles on the drainage area.

The total volume of runoff must include all drainage into the feedlot area from adjacent land unless it is diverted around the feedlot. The total volume of runoff may be reduced for covered or partly-covered feedlot operation provided that roof drains and underground piping are designed to carry the design storm runoff.

Separation Facilities

A settling pond should precede the retention pond and should be designed to retain the settleable solids contained in the feedlot runoff. The settling pond design features should include:

1. Volume should be 20 percent of total volume "V" calculated.

2. A depth not to exceed five feet to facilitate easy cleaning unless special non-clog pumps are used.

3. A freefall entry of wastes to prevent blockage.

4. Concrete apron inlets can be used on earthen ponds to support manure handling equipment.

5. Adequate fencing or other safeguards to prevent accidental entry by animals and humans alike.

The retention pond should have a capacity equal to 80 percent of the total volume and should provide capacity to contain runoff mainly during exceptionally wet years. The depth of the pond will depend upon land availability and the depth of groundwater since cleaning frequency is not an important factor. A designed spillway should be provided for the retention pond to prevent dike failure during extreme runoff conditions. Dewatering should be completed as soon as possible following high runoff periods (dependent on soil moisture levels in the disposal area). The pond levee freeboard must conform to State requirements.

Evaporation System

Evaporation ponds may be more economical in areas of low rainfall and high evaporation if the land is available. The loss of liquid contents from the pond would eliminate the need for costly pumping and sprinkling equipment.

Table 1-T shows average monthly annual precipitation and pan evaporation values for each drainage basin in the area (Figure 2-T). Actual evaporation values may be 60-80 percent (or less) of the pan evaporation values. Evaporation ponds may be applicable in drainage basin areas 3, 4, and 5 in Idaho; 3, 4, 5, and 6 in Oregon; and 4, 5, 6, 7, and 8 in Washington.

The evaporation pond will operate most efficiently when total annual inflow resulting from runoff is less than the total loss due to evaporation. It is therefore important to design the pond with an adequate surface area to allow a large volume of water to be evaporated during the summer months. The following equation should provide a minimum surface area for evaporation ponds:

$$S = (1.67 \times A \text{ (acre)} \times P \text{ (inches)} \times C) \div E \qquad \text{EQ.2}$$

where:

S = Minimum pond surface area in acres.

A = Area of runoff (including pond area) in acres.

P = Total annual precipitation in inches (Table 1-T).

C = 0.6; Runoff coefficient assuming 40 percent of annual precipitation is retained or absorbed on the feedlot.

E = Total annual pan evaporation in inches (Table 1-T).

The constant 1.67 is the evaporation correction value to convert Class A pan evaporation to lake evaporation.

The actual volume of the pond should be based upon the amount of rainfall occurring during the months of November through May of the following year because precipitation is greater than evaporation during this period.

Evaporation pond volume can be determined by the equation:

$$V = .083 \text{ (feet/inches)} \times A \text{ (acres)} \times P \text{ (Nov. - May)} \times C \qquad \text{EQ.3}$$

where:

V = Total evaporation pond volume in acre-feet.

A = Drainage acre in acres including pond area.

P = (Nov. - May) = Total precipitation in inches between November 1 and May 1 of the following year.

C = 0.6; Runoff coefficient. Assuming 40 percent of the rainfall during this period will be absorbed on the feedlot.

The pond depth can be determined by:

$$D \text{ (feet)} = V \text{ (acre/feet)} \div S \text{ (acres)} \qquad \text{EQ.4}$$

where:

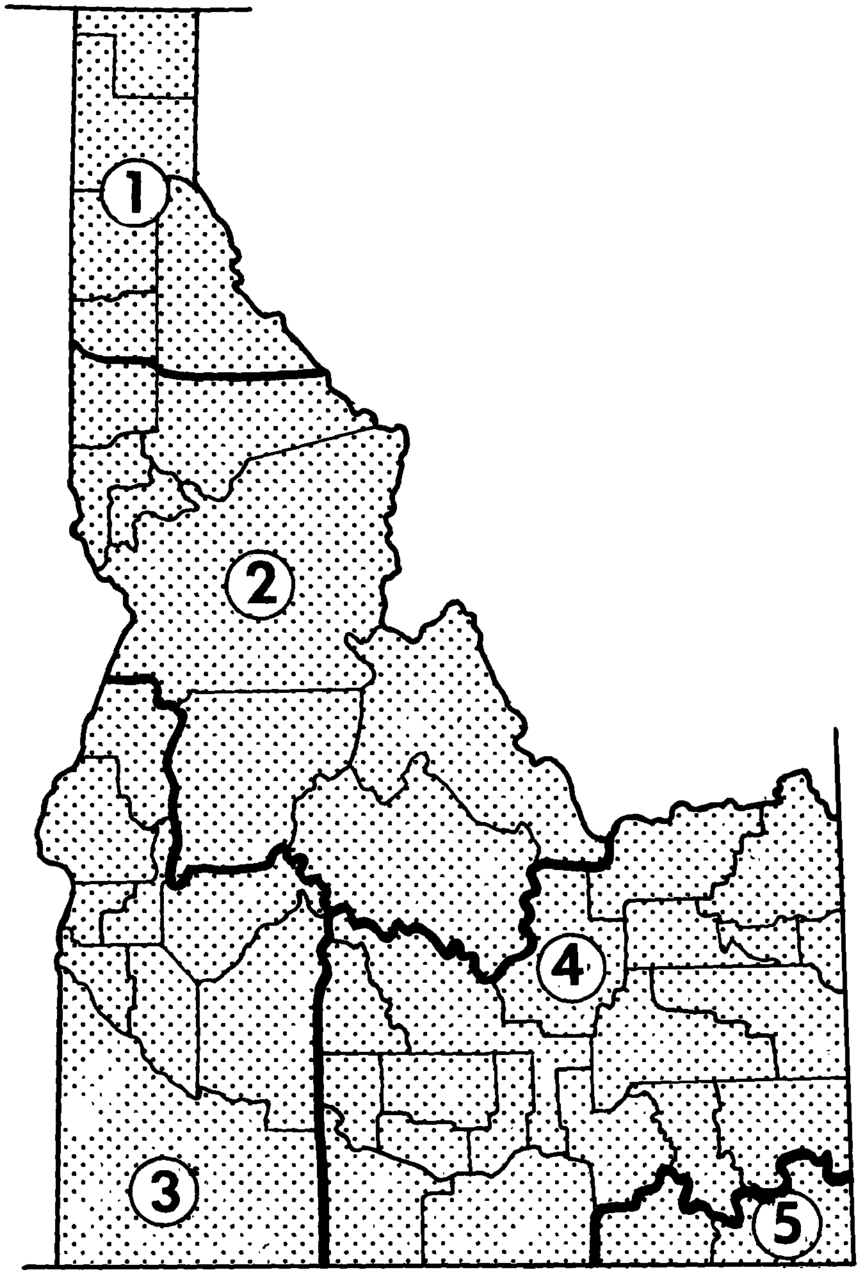
D = Pond depth in feet.

V = Pond volume in acre-feet.

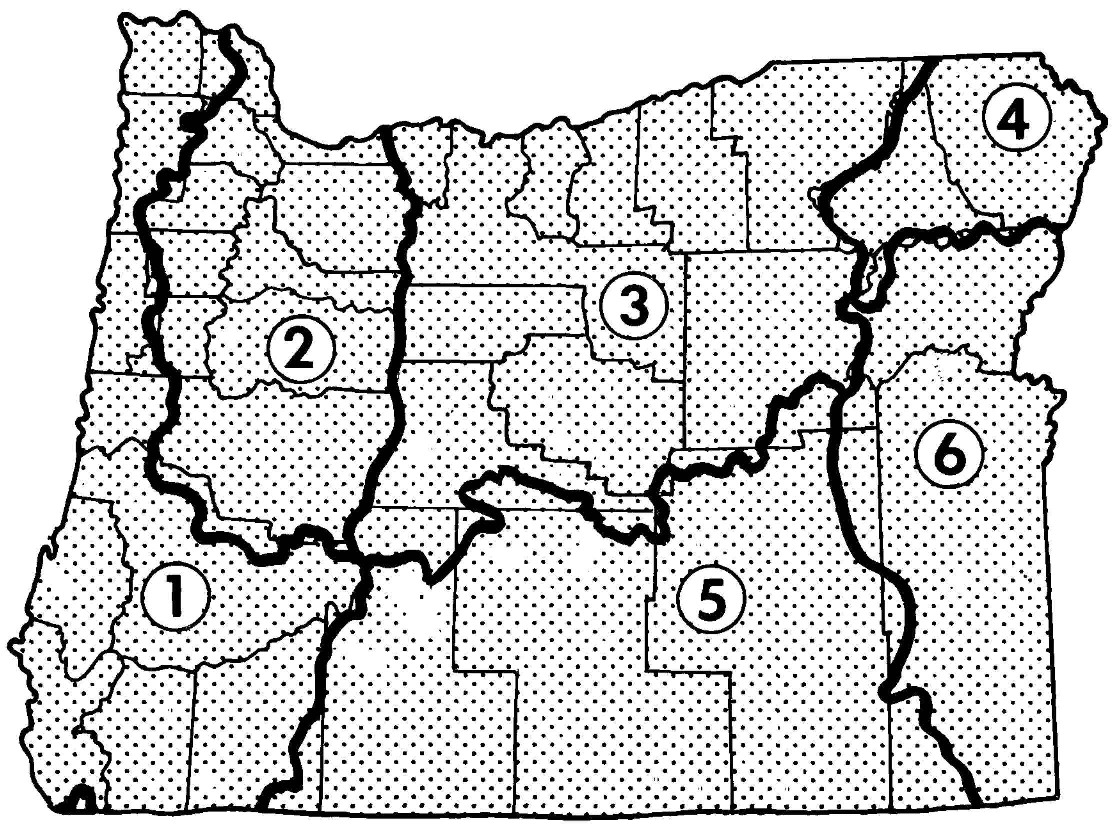
S = Pond surface area in acres.

The evaporation pond should be preceded by a settling pond. The settling pond should have the same design features as described under the "Short Term Facilities." The surface area requirement should be determined by the evaporation rate of the basin. The total volume requirement can be determined by both the sizes of the settling and evaporation basins.

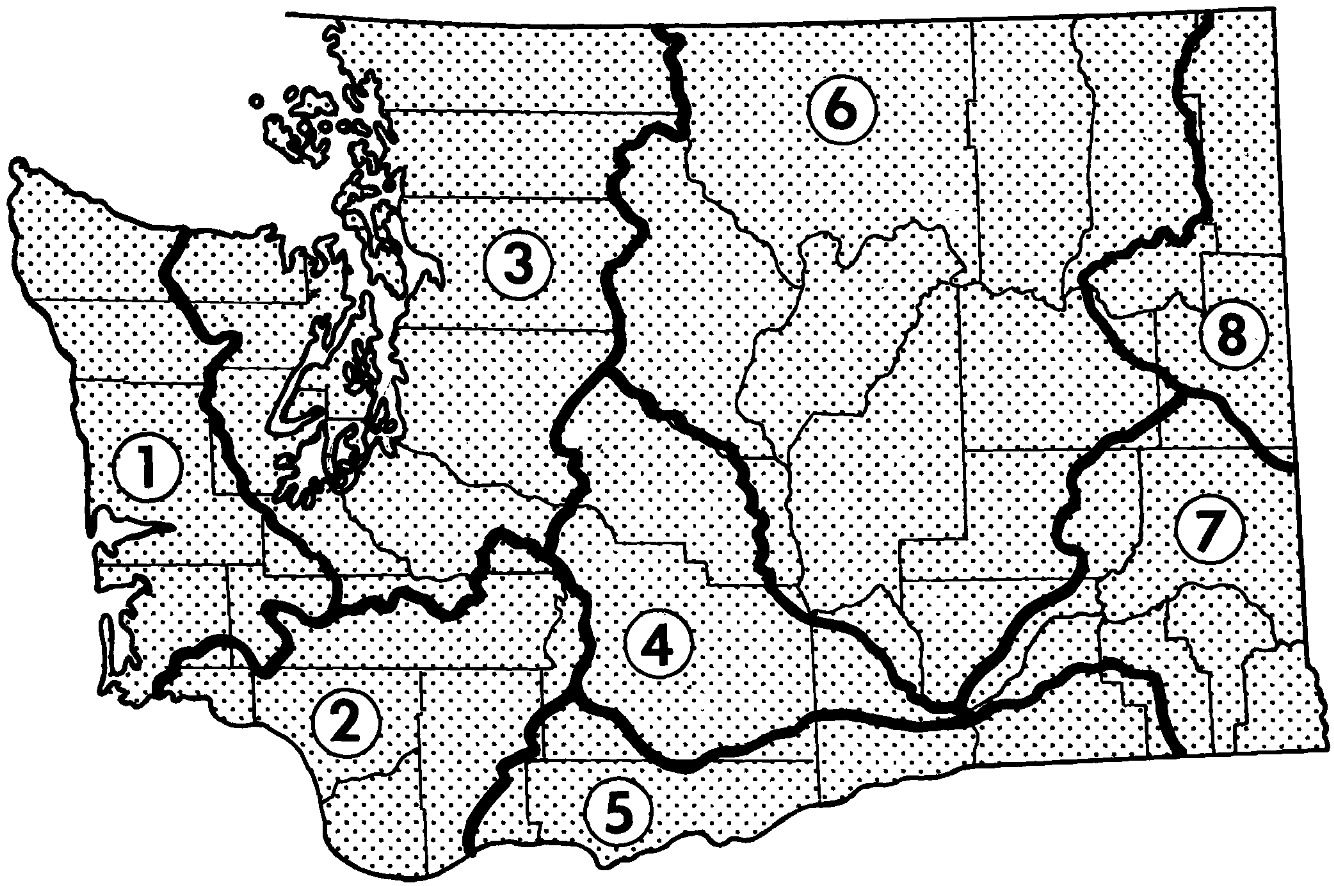
An overflow spillway should be provided for the evaporation pond to prevent dike failure during extreme runoff conditions. The evaporation pond levee freeboard should be one to two feet.



F-1 BASIN NUMBERS - IDAHO



F-2 BASIN NUMBERS - OREGON



F-3 BASIN NUMBERS - WASHINGTON

Table 1-T

GENERAL MONTHLY PRECIPITATION AND EVAPORATION IN IDAHO

Area / Month	1 Precip. Inches	1 Evap. Inches	2 Precip. Inches	2 Evap. Inches	3 Precip. Inches	3 Evap. Inches	4 Precip. Inches	4 Evap. Inches	5 ** Precip. Inches	5 ** Evap. Inches
January	3.2 - 5.1		0.5 - 4.8		1.0 - 3.6		0.7 - 2.1		1.4	
February	2.2 - 4.4		0.3 - 4.4		0.9 - 3.2		0.6 - 1.9		1.3	
March	1.8 - 3.7		0.4 - 4.4		1.1 - 2.8		0.6 - 1.4		1.3	
April	1.1 - 2.0		0.5 - 3.5		0.8 - 1.9		0.5 - 1.1		1.6	
May	1.4 - 2.2		1.1 - 3.3		1.0 - 2.4		0.9 - 1.6		1.3	
June	1.6 - 2.7		1.2 - 3.3		0.7 - 2.1		0.6 - 1.9		1.2	
July	0.7 - 1.1	35 - 40 Total	0.4 - 1.1	40 - 50 Total	0.1 - 0.6	40 - 55 Total	0.3 - 1.0	40 - 55 Total	1.0	36 - 72 Total
August	0.7 - 1.2		0.4 - 0.8		0.2 - 0.6		0.3 - 0.9		1.0	
September	1.3 - 2.1		0.6 - 2.0		0.3 - 1.2		0.6 - 1.4		1.1	
October	2.4 - 3.6		0.5 - 3.4		0.7 - 2.3		0.4 - 1.6		1.3	
November	3.1 - 4.7		0.3 - 4.7		0.9 - 3.2		0.4 - 1.6		1.3	
December	3.5 - 5.6		0.5 - 5.7		0.9 - 3.6		0.6 - 2.2		1.4	
TOTAL	23 - 38	35 - 40	6.9 - 41	40 - 50	8.8 - 27	40 - 55	7.6 - 17	40 - 55	12 - 15	36 - 72

** Monthly data for Area 5 are for Malad only

Table 1-T

GENERAL MONTHLY PRECIPITATION AND EVAPORATION IN OREGON

Area	1		2		3		4		5		6	
Month	Precip. Inches	Evap. Inches	Precip. Inches	Evap. Inches	Precip. Inches	Evap. Inches	Precip. Inches	Evap. Inches	Precip. Inches	Evap. Inches	Precip. Inches	Evap. Inches
January	2.78-10.29	20-43.5 Total	6.30-12.71	30-40 Total	1.13- 2.91	40-55 Total	.89- 1.99	40-50 Total	.80- 1.75	55-60 Total	.92- 7.29	40-55 Total
February	2.15- 8.35		4.79-10.25		.83- 2.11		1.03- 2.01		.76- 1.31		.88- 5.55	
March	1.78- 7.63		4.12- 8.74		.77- 1.72		1.32- 2.13		.59- 1.91		.65- 4.55	
April	1.06- 3.87		2.04- 4.04		.60- 1.52		1.34- 1.91		.51- .97		.57- 3.12	
May	1.47- 2.77		1.80- 2.74		1.06- 1.89		1.82- 1.90		.64- 1.88		.88- 2.83	
June	1.02- 1.69		1.24- 2.12		.96- 1.99		1.81- 1.96		.59- 1.56		.80- 2.19	
July	.21- .43		.31- .44		.21- .61		.46- .53		.21- .37		.17- .65	
August	.18- .52		.38- .62		.17- .60		.53- .55		.22- .33		.15- .89	
September	.60- 1.73		1.25- 1.75		.42- .93		.76- .94		.42- .64		.43- 1.61	
October	1.84- 5.49		3.52- 5.69		.78- 1.73		1.22- 1.69		.69- 1.11		.66- 2.96	
November	2.53- 8.56		5.35-10.78		1.12- 2.39		1.25- 2.29		.73- 1.12		.68- 5.93	
December	3.00-10.49		6.57-13.83		1.09- 2.73		1.22- 2.45		.63- 1.54		.91- 6.86	
Total	18.62-61.82	20-43.5	37.67-73.71	30-40	9.14-21.13	40-55	13.66-20.35	40-50	6.79-14.49	55-60	7.70-44.43	40-55

Table 1-T

GENERAL MONTHLY PRECIPITATION AND EVAPORATION IN WASHINGTON

Area	1		2		3		4		5		6		7		8	
Month	Precip. Inches	Evap. Inches	Precip. Inches	Evap. Inches	Precip. Inches	Evap. Inches	Precip. Inches	Evap. Inches	Precip. Inches	Evap. Inches	Precip. Inches	Evap. Inches	Precip. Inches	Evap. Inches	Precip. Inches	Evap. Inches
January	11 -17		6 - 7	2-3	3.5- 6		1 - 1.3		3.0		1 - 2		1 - 2.5		2.5- 3.5	
February	8 -14		5 - 7	2-3	2.5- 4		.6- .9		2.0		1 - 1.5		1 - 2		2.0- 2.5	
March	8 -13		5 - 6	2-3	2.5- 4		.5- .8	2-5	1.7		.5- 1	2-5	1 - 2		1.5- 2.5	
April	5 - 8		3 - 5	2-3	1.5-2.5	3.0	.5	2-5	.8	4-5	.5- 1	2-5	1 - 1.5		1 - 2	
May	3 - 5		2 - 3	2-3	1 - 2	4 -5	.5	2-5	.8	6-7	.5- 1	2-5	1.5		1 - 2.5	
June	3 - 4		2 - 3	5-7	1.5- 2	6.5	.8	6-9	.9	7-9	.5- 1	7-12	1.7		1.5- 3	
July	1 - 3	20-25 Total	.5- 1	5-7	.5- 1	4 -5	.2	6-9	.2	9-11	.2- .5	7-12	.5	25-30 Total	.5- 1.5	45-55 Total
August	1.5- 2		1 - 2	5-7	.5- 1	3.5	.2	6-9	.2	8-10	.2- .5	7-12	.5		.5- 1.5	
September	3 - 5		2 - 2.5	5-7	1.5- 2		.4	6-9	.6	4-6	.5- .8	7-12	1		1 - 1.5	
October	8 -12		4 - 6	2-3	2.5- 3.5		.7	2-5	1.6	2-3	.5- 1	2-5	1 - 2		1.5- 3	
November	10 -15		6 - 7	2-3	3.5- 5.5		.7-1.2	2-5	2.5		1 - 2	2-5	1.2- 2.5		2 - 3.5	
December	12 -19		8 - 9	2-3	4.0- 6.5		.8-1.4		3.0		1 - 2.5		1.5- 3.0		2.5- 4	
Total	73 -117	20-25	44.5-58.5	36-52	25 - 40	21-23	6.9-8.9	34-61	17.3	40-51	7.4-15.8	38-73	12.9-20.7	25-30	17- 32.5	45-55

Table 2-T

SOIL CHARACTERISTICS IN CATTLE FEEDING AREAS IN IDAHO

Basin	Present Major Land Use	General Soil Texture	General Soil Permeability Inches/Hour	General Soil Drainage	Soil Water Holding Capacity Inches in Profile
1	Cereals, clover and grass seed, pasture, hay, and alfalfa	Sandy and silty loams	0.2 to over 10	Poor to excessive	Less than 6 to over 10
2	Cereals, hay, potatoes, peas, clover, pasture	Sandy and silty loams	.5 to 8	Good to excellent	6 to 10
3	Cereals, potatoes, mint, hops, vegetables, hay	Silty to clayey	0.05 to 5	Bad to good	6 to over 10
4	Cereals, hay, potatoes, beans	Silty and sandy	0.05 to 2.5	Bad to good	6 to over 10
5	Pasture, cereals	Silty to clayey loams	0.05 to 2.5	Bad to good	6 to over 10

Table 2-T

SOIL CHARACTERISTICS IN CATTLE FEEDING AREAS IN OREGON

Basin	Present Major Land Use	General Soil Texture	General Soil Permeability Inches/Hour	General Soil Drainage	Soil Water Holding Capacity Inches in Profile
1	Crop land, hay, pasture	Silty loam	.2 to .8	Poor to good	6 to 10
2	Forage crops, cereals, and grass seed	Silty and sandy loam	.8 to 2.5	Good	6 to 10
3	Cereals, hay, crop land and pasture	Clay to Silt loam	.2 to 2.5	Poor to good	6 to 10
4	Crop land, hay and range land	Sandy silt to silty clay loam	.05 to 2.5	Bad to good	4 to 8
5	Crop land, pasture	Silty to sandy loam	.8 to 10	Poor to excellent	6 to 10
6	Crop land, pasture	silty loam to gravel	.05 to 2.5	Bad to good	4 to 10

Table 2-T

SOIL CHARACTERISTICS IN CATTLE FEEDING AREAS IN WASHINGTON

Basin	Present Major Land Use	General Soil Texture	General Soil Permeability Inches/Hour	General Soil Drainage	Soil Water Holding Capacity Inches in Profile
1	Pasture, silage cereals	Clay to silt loam	.8 to 2.5 inches/hour	Good	Greater than 10
2	Hay, pasture silage	Silty to gravelly loam	2.5 to 5.0	Good to excessive	6 to 10
3	Hay, cereals, pasture, truck crops	Silty to sandy loam	1.5 to 3.0	Good	6 to 10
4	Apples, alfalfa, sugar beets, mint, potatoes, beans, corn, seed crops, cereals, hops	Clay to silt loam	.8 to 2.5	Good	6 to greater than 10
5	Hay pasture silage	Clay to silt loam	.8 to 2.5	Good	6 to greater than 10
6	Alfalfa, fruit, potatoes, sugar beets, vegetable, grass seed, cereals, dryland farming	Sandy loam	.8 to greater than 10	Good	Less than 6 to 10
7	Cereals, hay, pasture, fruit, truck crops	Silty loam	.8 to 2.5	Good	6 to 10
8	Cereals, hay, pasture, alfalfa grass seed	Silty to gravelly loam	.8 to greater than 10	Good to excessive	6 to 10

LIST OF FIGURES

☆GPO 795-693

WASTE FROM ONE BIG FARM'S FEEDLOT EQUALS A CITY'S SEWAGE. RUNOFF INTO STREAMS IS SERIOUS, AND VAPORIZED AMMONIA CAN OVERDOSE LAKES A MILE AWAY WITH NITROGEN.

WASTE OF: