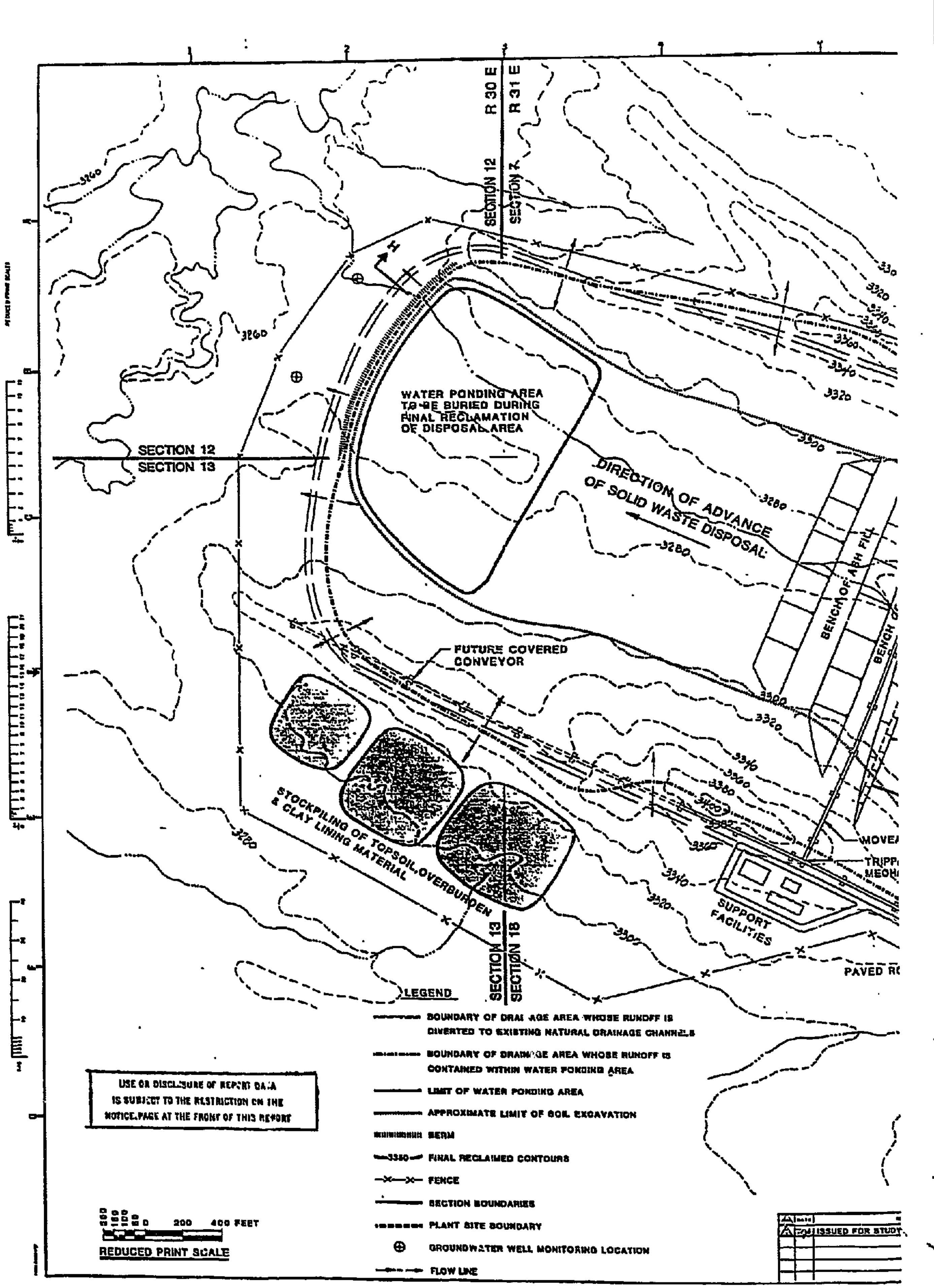
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SECTION 13
WATER PONDING AREA TO BE BURIED DURING FINAL RECLAMATION OF DISPOSAL AREA
DIRECTION OF ADVANCE OF SOLID WASTE DISPOSAL
BENCH OF ASH FILL
FUTURE COVERED CONVEYOR
STOCKPILING OF TOPSOIL, OVERBURDEN & CLAY LINING MATERIAL
SUPPORT FACILITIES
PAVED R
MOVE
TRIPP MECH
SECTION 13
SECTION 18
3260
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LEGEND
BOUNDARY OF DRAINAGE AREA WHOSE RUNOFF IS DIVERTED TO EXISTING NATURAL DRAINAGE CHANNELS
BOUNDARY OF DRAINAGE AREA WHOSE RUNOFF IS CONTAINED WITHIN WATER PONDING AREA
LIMIT OF WATER PONDING AREA
APPROXIMATE LIMIT OF SOIL EXCAVATION
BERM
3380 FINAL RECLAIMED CONTOURS
FENCE
SECTION BOUNDARIES
PLANT SITE BOUNDARY
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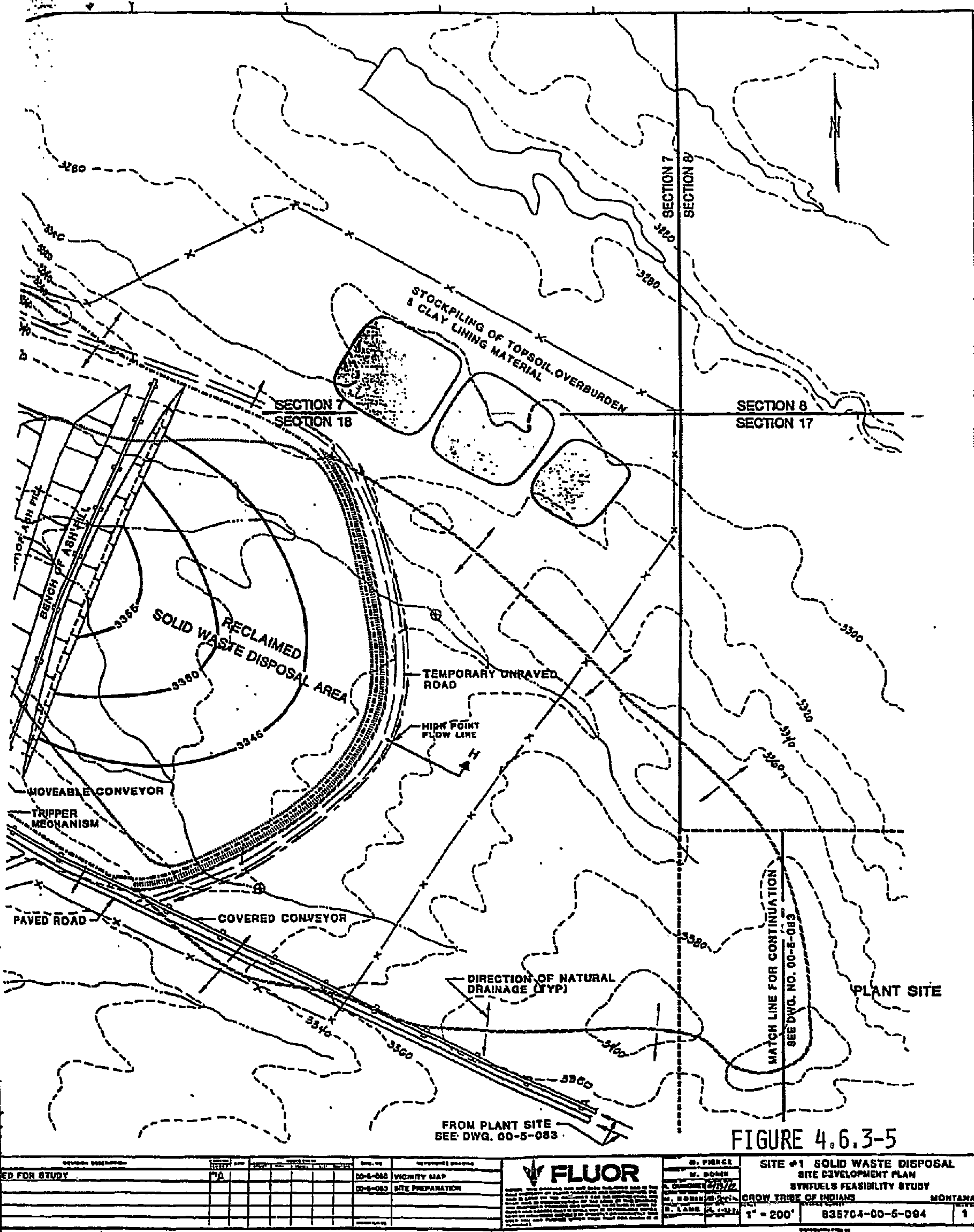

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SECTION 17
STOCKPILING OF TOPSOIL,OVERBURDEN & CLAY LINING MATERIAL
RECLAIMED SOLID WASTE DISPOSAL AREA
BENCH OF ASH FILL
TEMPORARY UNPAVED ROAD
HIGH POINT FLOW LINE
MOVEABLE CONVEYOR
TRIPPER MECHANISM
PAVED ROAD
COVERED CONVEYOR
DIRECTION OF NATURAL DRAINAGE (TYP)
FROM PLANT SITE SEE DWG. 00-5-083
MATCH LINE FOR CONTINUATION SEE DWG. NO. 00-5-083
PLANT SITE
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VICINITY MAP
SITE PREPARATION
FLUOR
SITE #1 SOLID WASTE DISPOSAL
SITE DEVELOPMENT PLAN
SYNFUELS FEASIBILITY STUDY
CROW TRIBE OF INDIANS
MONTANA
1" = 200'
835704-00-5-094
1

FIGURE 4.6.3-5

TABLE 4.6.3-2

SITE DEVELOPMENT FOR SOLID WASTE DISPOSAL PLAN FOR SITE 1

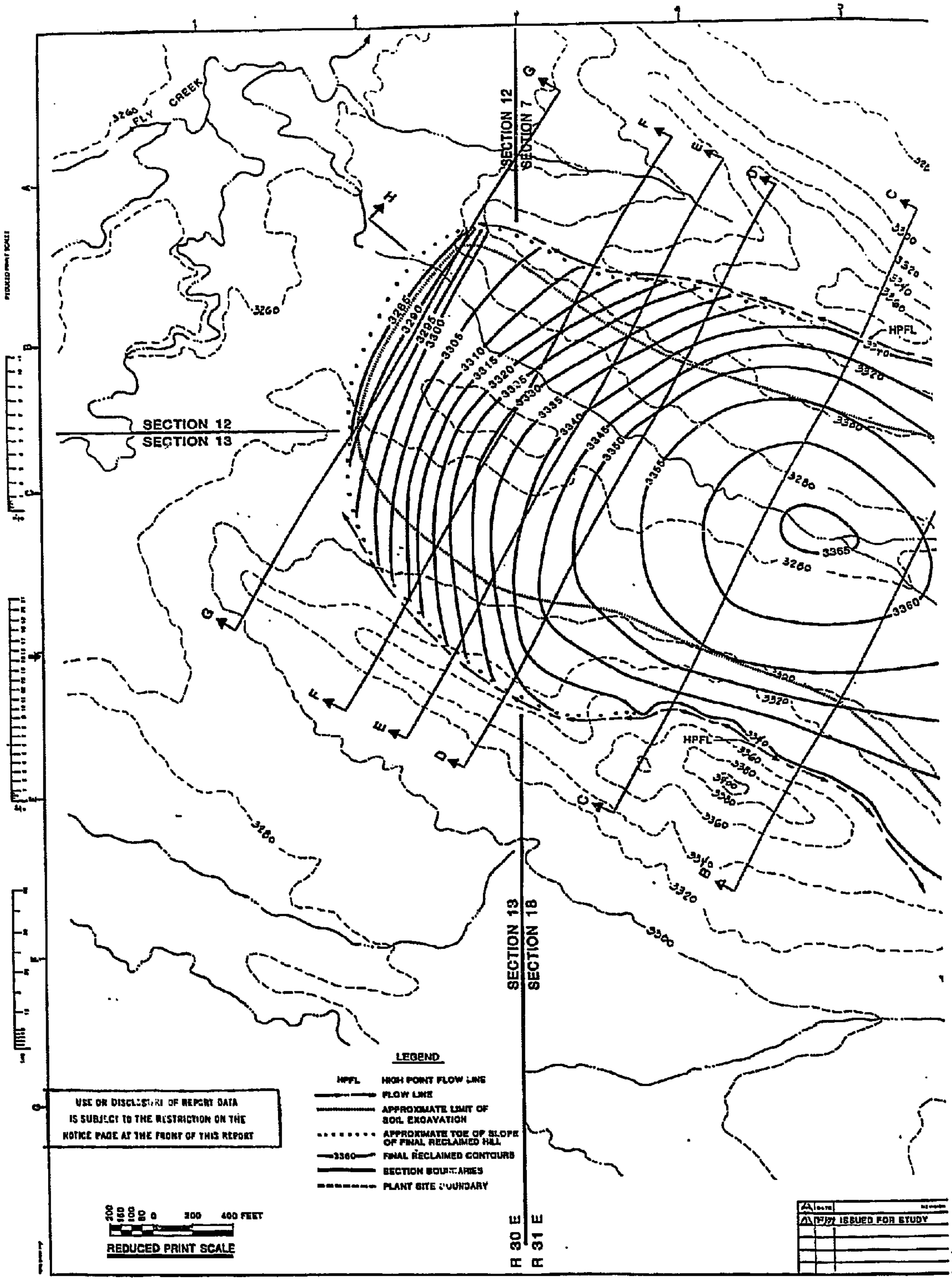
Item	Initial 2 Years	Balance 23 Years	Comments
Excavate topsoil	63,000 cubic yards over 39 acres	312,000 cubic yards over 39 acres	1 foot deep, stockpile nearby.
Excavate overburden.	735,000 cubic yards	2,790,000 cubic yards	Stockpile.
Construct upstream berm	92,000 cubic yards compacted	—	Average height above existing grade, 10 feet.
Construct clay liner bottom	312,000 cubic yards compacted over 39 acres	1,310,000 cubic yards compacted over 162 acres	Five feet thick. Permeability is 10^{-7} cm/sec.
Excavate for downstream drainage pond	792,000 cubic yards	—	Stockpile.
Construct downstream berm	41,500 cubic yards	—	Average height above existing grade, 10 feet.
Construct clay liner bottom for drainage pond	278,000 cubic yards compacted over 34.5 acres	—	Five feet thick.
Excavate drainage channel in disposal area	2,800 cubic yards	—	Stockpile 100 feet long, 5 feet deep, trapezoidal.

As illustrated in Figure 4.6.3-5, the majority of the solid wastes will be transported from the plant to the disposal site via a covered belt conveyor. Approximately 6,500 feet of the conveyor will be fixed and 4,000 feet will be movable and equipped with a tripper. The conveyor will be 24 in. wide. The solid wastes will be placed in lifts and compacted by heavy vehicle traffic. Moisture will be added as required to facilitate the compaction and the control of fugitive dusts. A diversion channel within the active areas of the waste site will collect surface water runoff and drain to a downstream sedimentation pond as shown in Figure 4.6.3-5. The solid wastes within the disposal area will completely capsulate with 5 feet of clay compacted to a permeability of 10^{-7} cm/sec or less as illustrated in Figure 4.6.3-7. The compacted clay surface will be graded in such a manner that any infiltrating groundwater will be diverted away from the disposal area. An additional 5 feet of overburden followed by 1 foot of topsoil will be placed over the compacted clay liner as also shown in Figures 4.6.3-6 and 4.6.3-7. Reclamation of the disposal area will then be completed by planting grass and shrubs similar to the nondisturbed landscapes in the general area encompassing the disposal site. Thus, capping, contouring, and revegetation will produce a topography, as shown in Figure 4.6.3-7, similar in appearance to existing nondisturbed areas.

The utilities needed at the disposal facility are electric power, water, and telephone. Power is needed to operate the conveyors and for lighting. Water is needed for drinking water supply, machine maintenance, and dust control. Telephone service is needed for communications with other plant operating units.

Three buildings will be located at the solid waste disposal facilities. They are a (1) office building, (2) security building, and (3) equipment maintenance and storage building. These buildings will be of steel frame construction, with metal wall and roof panels. The equipment maintenance and storage building will contain a 5-ton overhead bridge crane with a 50-foot span.

The perimeter of the solid wastes disposal site will be fenced to prevent unauthorized entry. There will be 17,500 feet of chain link fencing, 8 feet high with four 32-foot wide double-swinging gates, and four $3\frac{1}{2}$-foot wide passenger walkway



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HPFL HIGH POINT FLOW LINE
FLOW LINE
APPROXIMATE LIMIT OF SOIL EXCAVATION
APPROXIMATE TOE OF SLOPE OF FINAL RECLAIMED HILL
3360 FINAL RECLAIMED CONTOURS
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PLANT SITE BOUNDARY
USE OR DISCLOSURE OF REPORT DATA IS SUBJECT TO THE RESTRICTION ON THE NOTICE PAGE AT THE FRONT OF THIS REPORT
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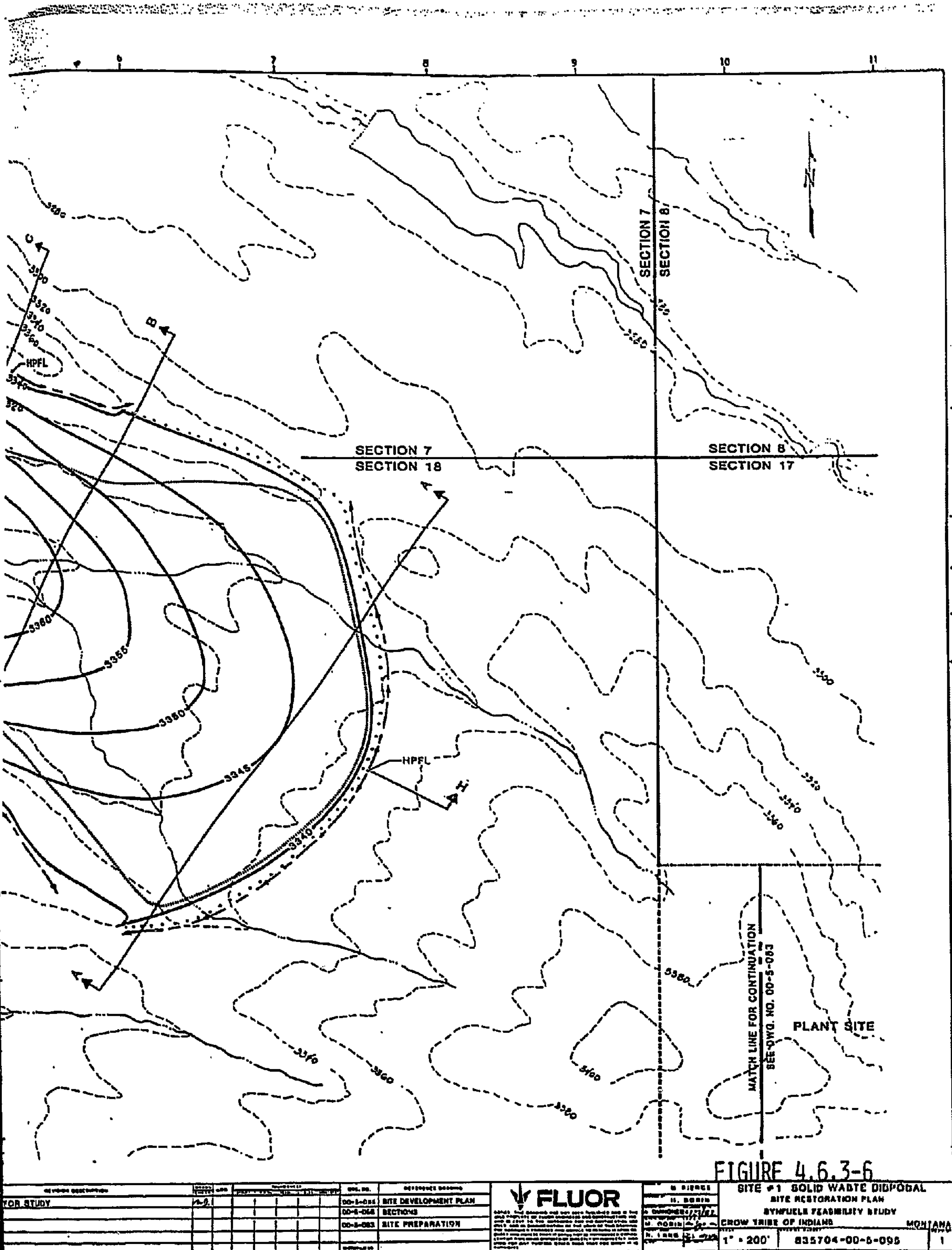
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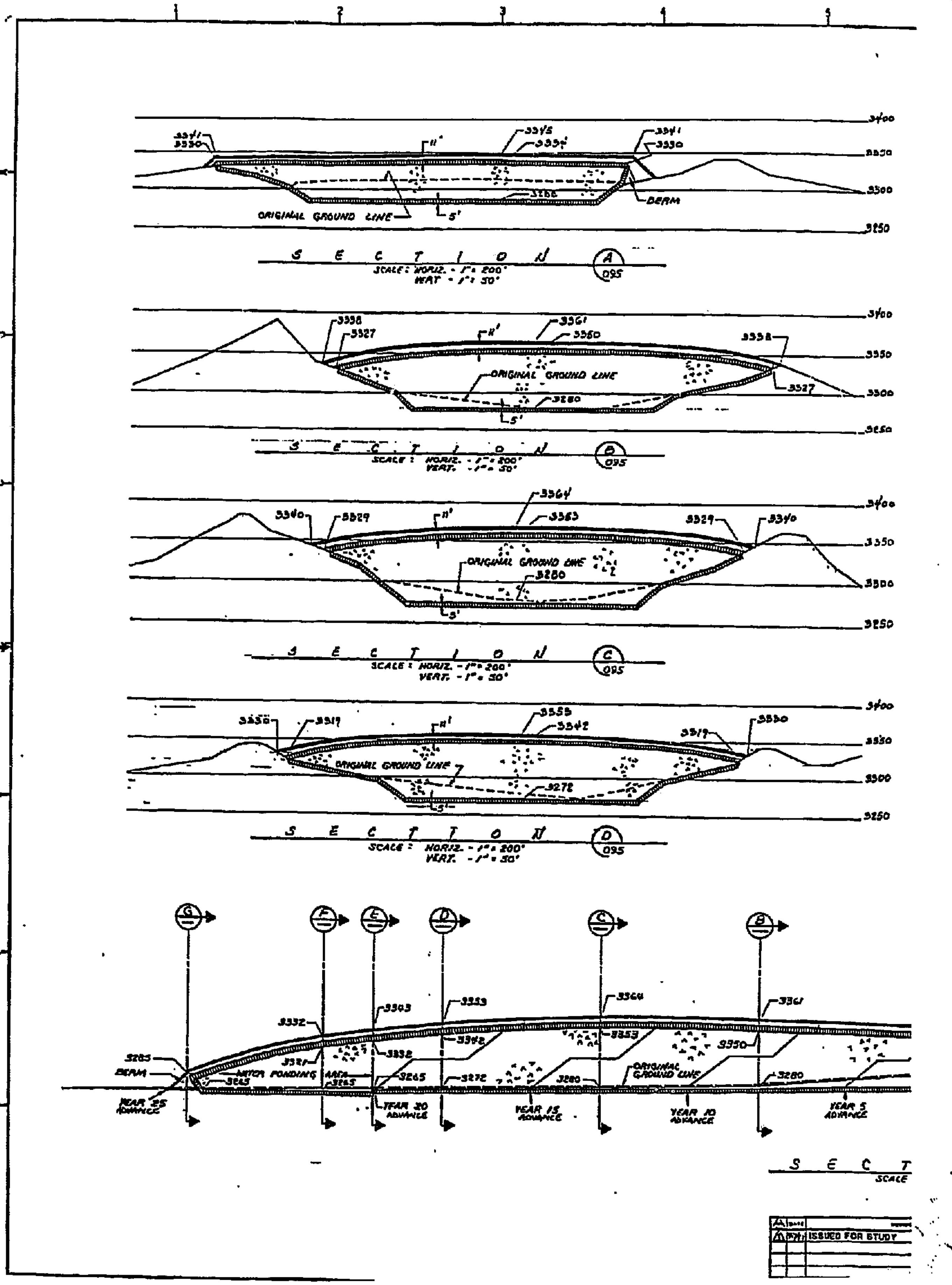
SECTION 17
HPFL
HPFL
MATCH LINE FOR CONTINUATION
SEE DWG. NO. 00-5-083
PLANT SITE
SITE #1 SOLID WASTE DISPOSAL
SITE RESTORATION PLAN
SYNFUELS FEASIBILITY STUDY
CROW TRIBE OF INDIANS
MONTANA
1" = 200'
835704-00-5-095
FLUOR
00-5-084 SITE DEVELOPMENT PLAN
00-5-088 SECTIONS
00-5-083 SITE PREPARATION

FIGURE 4.6.3-6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VERT. - 1" = 50'
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ORIGINAL GROUND LINE
BERM
MINOR PONDING AREA
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YEAR 20 ADVANCE
YEAR 15 ADVANCE
YEAR 10 ADVANCE
YEAR 5 ADVANCE
SECT
SCALE
ISSUED FOR STUDY

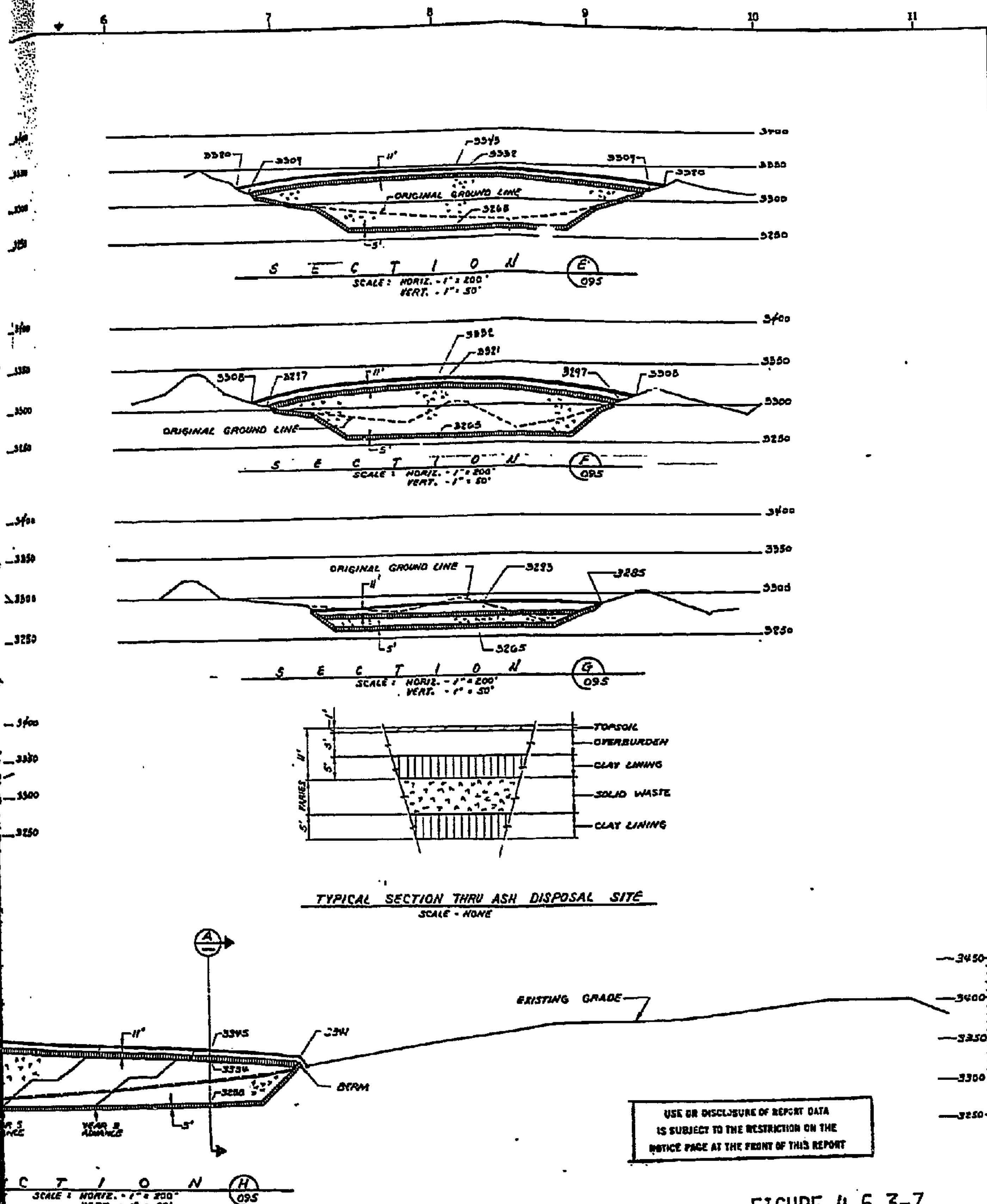


FIGURE 4.6.3-7

FLUOR

SITE #1 SOLID WASTE DISPOSAL SECTIONS
SYNFUELS FEASIBILITY STUDY
CROW TRIBE OF INDIANS — MONTANA

AS SHOWN | 835704-00-5-096 | 1

00-5-095 SITE RESTORATION PLAN

gates. In addition, security personnel will periodically patrol the site perimeter.

4.6.3.2.1 Background Water Quality Monitoring

Preoperational background monitoring will be performed to evaluate the quality of the groundwater in the solids disposal site area. Monitoring wells will be installed around the periphery of the disposal site 1 to 2 years prior to the initial site development. Samples will be taken quarterly and analyzed for the parameters identified in Table 4.6.3-3.

During the operational phase of the solid waste disposal site, four monitoring wells, two hydraulically upgradient and two downgradient of the leachate path, will be installed. The comprehensive test parameters listed in Table 4.6.3-3 will be monitored on a quarterly basis, while the following well indicator parameters will be monitored on a monthly basis: field pH, field temperature, field specific conductance, and depth to water.

Quarterly samples of soil and vegetation should be taken during the preoperational monitoring program to establish baseline concentrations of possibly hazardous (by EPA standards) or toxic trace elements and during the operational phase of projects to monitor possible uptake due to any inadvertent leaching of the solid wastes. Additionally, pH and eH soil measurements should be included on a quarterly basis during both phases of the proposed monitoring program.

4.6.3.3 Ash Leachability Characteristics

As previously mentioned, representative coal samples from both Westmoreland and Shell have been processed in Lurgi's test facilities. The resulting ash was retained and subjected to a leaching test by Associated Laboratories of Orange,California. The results of these preliminary tests do not indicate that significant quantities of hazardous (toxic) chemicals will leach out of the ash.

TABLE 4.6.3-3

COMPREHENSIVE TEST PARAMETERS: PREOPERATIONAL MONITORING PROGRAM, SOLIDS WASTE DISPOSAL FACILITY

Alkalinity ($CaCo_3$)	Manganese (Mn)
Arsenic (As)	Magnesium (Mg)
Barium (Ba)	Mercury (Hg)
Bicarbonate (HCO_3)	Molybdenum (Mo)
Boron (B)	Nitrate & Nitrite (as N)
Bromine (Br)	eH
Cadmium (Cd)	Potassium (K)
Calcium (Ca)	Selenium (Se)
Carbonate (CO_3)	Silver (Ag)
Chloride (Cl)	Sodium (Na)
Chromium (Cr)	Specific Conductance
Fluoride (F)	Strontium (Sr)
Hardness ($CaCO_3$)	Sulfate (SO_4)
Iron (Fe)	Total Dissolved Solids (TDS)
Lead (Pb)	

Unquenched ash samples were subjected to two types of leachate tests. The basic test was performed according EPA's Extraction Procedure (EP) test for hazardous chemicals. The EPA test procedure is documented in the Federal Register, Volume 45, No. 98, page 33127, 19 May 1980. Analysis of the leachate indicates that contaminant concentrations do not exceed the limits for hazardous wastes as defined by EPA.

A second test exposed dry ash samples to 5 times the mass of deionized water at a boiling reflux condition for 24 hours. The filtrates were analyzed for the components Lurgi found to be present in the coal ash. Again, no critical concentrations of hazardous chemicals were discovered. Table 4.6.3-4 shows a comparison of the EPA standard for hazardous chemicals with the test results. All quantities are in milligrams/liter.

Nevertheless, due to the technical complexity of the potential leachability of solid waste residues when acted upon by water at a soil surface or subsurface earthen disposal area, the understanding of the possible physico-chemical processes is presently incomplete. In the case of crystalline mineral solids, which are composed of a variety of inorganic as well as some organic chemical species, there will eventually be an equilibrium, probably between precipitation and dissolution reactions.

A crystal under attack by leaching fluid contains a structural array of major ions such as calcium and hydroxyl ions, as well as surface-absorbed trace ions, such as arsenic, lead, selenium, or other potentially hazardous species. As long as the crystalline solid remains intact, the movement (migration) and attenuation of these minor species in landfill situations will be controlled by adsorption-desorption processes.

Unfortunately, adsorbing anions are not simply oppositely charged mirror images of adsorbing cations. Protolyzable anions are smaller and less hydrated; yet they contribute more strongly to surface charge than do their larger, more hydrated hydrolyzable cationic counterparts.

TABLE 4.6.3-4

ASH LEACHATE TESTS: WESTMORELAND AND SHELL COAL SUPPLIES

Contaminant	EPA Limit	SHELL COAL E.P. Test	SHELL COAL Reflux	WESTMORELAND COAL E.P. Test	WESTMORELAND COAL Reflux
Aluminum			20.4		1.6
Arsenic	5.0	ND 0.01	ND 0.01	ND 0.01	ND 0.01
Barium	100.0	10.3	11.5	5.4	7.1
Beryllium		ND 0.01	ND 0.01	ND 0.01	ND 0.01
Boron			0.86		1.40
Cadmium	1.0	ND 0.01	ND 0.01	ND 0.01	ND 0.01
Calcium			224		192
Carbonate			258		105
Chloride			14		12
Chromium	5.0	ND 0.01	ND 0.01	ND 0.01	ND 0.01
Copper		ND 0.01	ND 0.01	ND 0.01	ND 0.01
Flouride			.38		.54
Lead	5.0	ND 0.01	ND 0.01	ND 0.01	ND 0.01
Mercury	0.2	0.004	ND 0.002	0.004	ND 0.0002
Nickel		ND 0.01	ND 0.01	ND 0.01	ND 0.01
Phosphorus			0.06		0.06
Potassium			20		8
Selenium	1.0	ND 0.01	ND 0.01	ND 0.01	ND 0.01
Silver	5.0	ND 0.01	ND 0.01	ND 0.01	ND 0.01
Sodium			16		160
Strontium			18		15
Sulfur			114		218
Zinc			0.12		0.16

Notes: Concentrations listed are in mg/liter.
ND = not determinable.

Solid adsorbents also vary dramatically, even those having the same chemical identity. Factors such as crystalline morphology, number of surface sites, and porosity can contribute to a variety of behavior. Moreover, once binding has occurred there begins a competition between the adsorbent and the aqueous solvent for the minor adsorbate species. Whether the solvent or adsorbent wins may be mediated by a whole range of factors, including other ions present, pH, stoichiometry, temperature, electrostatic charge (surface effect), presence of ligands or chelated compounds, oxidation-reduction (redox) potential, and possibly several other parameters. The attenuation of trace elements by earth materials has received some attention. Among such studies are those of Fuller et al. (1976) and Griffin et al. (1976,1977) which are concerned with soil or clay attenuation of various constituents in municipal landfill leachates. Although not directly related to coal, these studies have develped criteria for predicting migration trends of certain potentially hazardous constituents through soils. Fuller (1977) summarized the literature for 12 constituents, which he grouped with respect to mobility in soil under aerobic conditions (Table 4.6.3-5). The same publication contains results of studies of the relative mobility of eight constituents in soils under anaerobic conditions using landfill leachate as the transporting medium (Table 4.6.3-6). (References 21, 24, 25).

Griffin et al. (1976, 1977) studied the effectiveness of clay liners in attenuating pollutants. They found that Cl, Na, and water-soluble organic compounds (COD) were relatively unattenuated by passage through columns of clay; K, NH_4, Mg, Si, and Fe were moderately attenuated; and the metals Pb, Cd, Hg, and Zn were strongly attenuated by even small amounts of clay. Concentrations of Ca, B, and Mn were markedly higher in the effluents than in the original leachate. The potential usefulness of clay materials as liners for waste disposal sites depends to a large extent on the pH of the leachate solutions and on ionic competition during the ion adsorption process. Adsorption of cationic heavy metals—Pb, Cd, Zn, Cu, Hg, Cr^{3+}—was found to increase as the pH increased, while adsorption of the anionic heavy metals—Cr^{6+}, As, and Se—decreased as the pH increased. The presence of leachate reduced by as much as 85 percent the amounts of cationic heavy metals removed from solution, whereas leachate had relatively little effect on the amounts of the anionic heavy metals removed by the clays. It was concluded that removal of the

TABLE 4.6.3-5

RELATIVE MOBILITY OF 12 CONSTITUENTS IN SOILS

(Aerobic Conditions)

Mobility Class	Element	Comments
I. Relatively Mobile		
	Cyanide - CN^{1-}	Not strongly retained by the soil.
	Selenium - $HSeO_4$ & SeO_3	Not strongly retained by the soil at normal pH levels.
II. Moderately Mobile		
	Iron, Zinc, Lead, Copper	Absorbed more strongly by the soil in the order of $CU^{2+} \rightarrow Pb^{2+} \rightarrow Zn^{2+}$ Fe^{2+}. Stability for complexes of any given type should be increasing in the order of $Fe \rightarrow Zn \rightarrow Pb \rightarrow Cu$.
	Beryllium - Be^{2+}	(Chemistry in soils probably similar to aluminum.)
III. Slowly Mobile		
	Arsenic - H_2AsO_4	Mobility similar to phosphorus.
	Cadmium - Cd^{2+}	Forms insoluble precipitates in oxidizing conditions.
	Chromium - Cr^{3+} (or Cr^{6+})	Forms insoluble precipitates in oxidizing conditions.
	Mercury - Hg^{2+}	Retained in the surface layer of most aerated soils.
	Asbestos - 2u	Particles less than 2u are retained in the surface layer of soils like clay
IV. Immobile		
	Asbestos - 2u	Particles 2u, or greater than clay size, are retained on the surface of soils.

Source: Fuller (1977)

TABLE 4.6.3-6

RELATIVE MOBILITY OF 8 CONSITUENTS
IN LANDFILL LEACHATE THROUGH SOILS

(Anaerobic Conditions)

Soil Series	Element in Leachate
Acid Soils	
Ava	
Kalkaska	
Wagram	Zn, Cd, As, Cr, Se, Cu
Davidson	Be Pb
Molokai	In order of decreasing mobility
Neutral to Alkaline Soils	
Anthony	
Fanno	Cr, As, Se, Cd, Be, Cu
Mohave (limy)	Zn Pb
Mohave	In order of decreasing mobility
Nicholson	

Source: Fuller (1977)

heavy-metal cations from solution is primarily a cation exchange-adsorption reaction affected by pH and ionic competition, whereas removal of the heavy-metal anions is primarily an anion-adsorption reaction in which the monovalent ion is the predominant one being adsorbed. Precipitation of the heavy metal cations in leachate was an important attenuation mechanism at pH values of 5 and above. No precipitation of the heavy-metal anions was detected in the pH range of 1.0 to 9.0.

Various researchers (ES & T, Vol. 18, No. 4, 1982) have found that certain classes of organic fluids also have induced an increase in the permeability of clay soils, especially if such fluids reaching a clay liner are in concentrated form. The foregoing work has revealed that three types of organic fluids—basic (analine), neutral (methanol), and neutral nonpolar (xylene)—induce significant permeability increases. Indeed, methanol-treated soil cores have shown actual structural rearrangement of soil particles, with large pores and cracks formed in the surface of the soils. Xylene has also brought about structural changes and large permeability increases.

4.6.3.4 Site 1 Solid Waste Impacts Evaluation

Since the solid waste disposal facility at Site 1 is designed for complete containment or isolation of the solid wastes by encapsulation with 5 feet of clay, as discussed previously in Section 4.6.3.2, any potential water quality impacts must be predicated upon either (1) transport of aqueous anions or cations derived from solubilized solid wastes through the clay liner; (2) fairly extensive fracturing of that liner due to some inadvertent catastrophic natural event such as an earthquake, flood, etc.; or (3) improper liner preparation and construction procedures, thereby creating the necessary transport pathway for possible solid waste contaminants to nearby surface waters or possible groundwater aquifers.

Recalling that the clay liners will be specifically designed to have a permeability of 10^{-7} cm/sec or less, natural penetration through a 5-foot liner thickness as set forth in RCRA regulations would require 17,692.49 days (48.36 years) under normal gravitational hydrostatic pressures for a possible aqueous contaminant to penetrate the liner. Since significant attenuation of most contaminants would most certainly be effected during this time interval, it may be concluded that potentially adverse water quality impacts to the area encompassing Site 1 are quite remote if the clay liner remains intact and provided that ancillary hydrostatic head forces are not present to increase the liner permeability, based upon the results of the ash leachability tests present in Table 4.6.3-4.

The introduction of hydrostatic head forces can be precluded by assuring that neither the natural drainages or flooding conditions will result in drainage into the solid waste disposal facility area—a factor that has been accounted for in the previously discussed Site 1 solid waste facility design. Additionally, the natural geohydrolic environment of the Site 1 area lends itself to the mitigation of any potentially adverse water quality impacts from either solid or liquid process waste residues.

The geology of the Site 1 area previously described in Section 4.1.2 indicates that stiff clays predominate over hard claystone bedrock at depths of 3 to 7 feet. The clays are silty, sand, calcareous, and occasionally porous. The claystone bedrock is slightly sand and contains scattered bentonitic clay lenses. The bedrock consists primarily of the Niobrara and Carlile shale members of the Colorado Group of the Cody Shale Formation of the Upper Cretaceous series. Preliminary test borings indicate that these clays and claystone bedrock expand when wetted indicating both relatively high neutral impermeability and low unsaturated interstitial pore volumes—natural conditions highly suited to the mitigation of potential aqueous contaminants and reduction of a potential liquid pathway for contaminant transport.

Furthermore, as related in Section 4.1.3 of this report, the Cloverly Formation in the Lower Cretaceous series is a potential groundwater source underlying the Site 1 area, but this formation may be overlain by 2,000 feet or more of the Cody Shale. Although the sandstone formations of the Montana Group of Cody Shale could serve as groundwater aquifers, the potential yield would be very low (less than 50 gpm) due to the limited area of recharge and possibly limited formation thickness. Additionally, preliminary test borings in the Site 1 area indicated no free water in any of the test holes to the maximum depth drilled of 20 feet. Hence, potential water quality impacts to the groundwater aquifers by seepage should have little effect on any near-surface construction such as a solids waste disposal plant. Additionally, surface water quality drainage and evaporation should be limited to the overburden section above the clay cap of the disposal area.

4.6.3.5 Site 23 Solid Waste Impacts Evaluation

Although the process solid wastes would most likely be returned to the proposed Shell mining area for disposal from Site 23, it is proposed that a similar isolation or containment design approach to solid waste disposal as has been developed for Site 1 should be applied as well at Site 23. In fact, perusal of the possible natural geohydrologic environmental setting at Site 23 dictates a possibly greater need for assurance of complete containment of the solid wastes at Site 23 to minimize potentially adverse water quality impacts.

As previously discussed in Section 4.1.3, Water Environment, the major water-bearing strata in the southeastern section of the Crow Reservation in the proposed Shell mine/Site 23 area are the alluvial deposits within the Squirrel, Youngs, Tanner, and Little Youngs Creek valleys; the major coal seams, associated clinkers, and sandstone beds in the Tongue River Member of the Fort Union Formation; the Fall River Formation; and the Madison Group. Both the major groundwater aquifers—the alluvial deposits of the Squirrel, Youngs, Tanner, and Little Youngs Creek valleys—and Anderson and Dietz coal seams of the Tongue River Member and associated clinkers form a more or less continuous groundwater unit (see Figure 4.1.3-8 of Section 4.1.3) from the Wolf Mountains on the west to the Tongue River on the east. The movement of both the surface water and the groundwater is toward the Tongue River and external to the Crow Reservation. The potentiometric surface of the groundwater is also near ground surface levels (see Figure 4.1.3-9 of Section 4.1.3). Hence, the possibility could exist for a nearly continuous transport path for potential aqueous contaminants from synfuels plant process liquids and solids residues if the proposed isolation or containment liners are circumvented for any reason in the Shell mine/Site 23 area. Thus, additional precautions must be taken in the site selection, design, and construction of the aforementioned disposal areas—

especially the solid waste facility—in the Shell mining area to make certain that (1) the waste disposal containment liners are capable of high, long-term integrity, and (2) continuous, aqueous, contaminant surface water or groundwater pathways are not possible in the waste disposal area, in order to preclude any potentially adverse water quality impacts to the Tongue River drainage system.

Additionally, the possibility of acid drainages from the mining operation entering a proposed synfuels plant liquids or solid waste disposal area should also be mitigated by appropriate design and construction measures within the potential waste disposal areas. The inadvertent infiltration of acid (low pH) mine liquid wastes into the aqueous solids waste leachate, for example, would tend to increase the mobility and lower the attenuation of the aqueous heavy cation trace elements (Pb, Cr, Cd, etc.), as previously cited in Section 4.6.3.3, thereby increasing the potential for adverse water quality impacts.

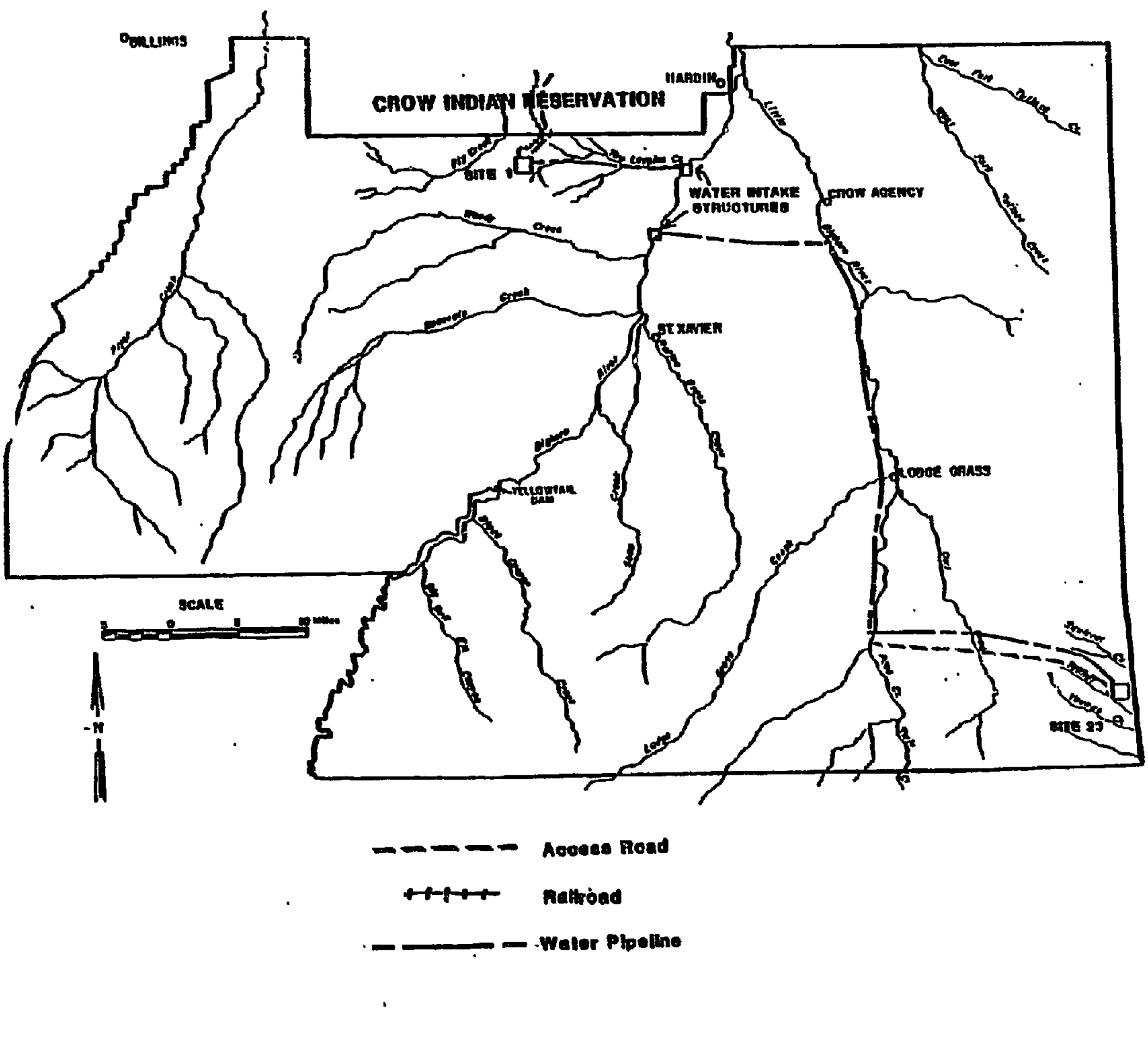
4.6.4 Preliminary Wildlife Resource Impact Assessment

A preliminary wildlife assessment of a coal gasification plant at either of the two proposed sites (Figure 4.6.4-1), including ancillaries within the Crow Reservation indicates that potential adverse impacts to certain wildlife species are possible. Potential impact assessments (based on limited information) for each proposed site are provided below and should be considered as preliminary until site- and corridor-specific wildlife information is obtained.

4.6.4.1 Site 1

Plant Construction (Including Ancillaries). Preliminary design data indicate that approximately 1,250 acres will be required, and thus disturbed, for Site 1. Approximately 960 acres will be encompassed within the plant boundaries and another 290 acres will be required for the access roads, railroads, and water pipeline. An additional 300 to 600 acres will be required for a waste disposal site. Wildlife habitat within and adjacent to these proposed sites could be considered lost

FIGURE 4.6.4-1
CANDIDATE SITE LOCATIONS AND PROPOSED CORRIDORS



for the duration of the project. Terrestrial wildlife with limited mobility and small home-range sizes will be most affected. Sharp-tailed grouse are known to be quite abundant within the general area and loss of habitat will directly impact populations.

Disturbances associated with the construction process could impact pronghorn antelope and sharp-tailed grouse depending on the timing of construction activities. Uncontrolled access and activities could result in further disturbance, harassment, and poaching thereby directly impacting wildlife populations particularly during winter months when populations such as pronghorn antelope and sharp-tailed grouse are concentrated. However, controlled access to both the Crow synfuels plant and the solid waste disposal facility will be maintained as a mitigation measure by total perimeter security fencing to prevent inadvertent entry by ambulatory wildlife.

Water quality degradation of Fly Creek and Two Leggins Creek could increase if measures are not taken to contain runoff and resultant sediment loads. Depending on the quantity of additional sediment resulting from construction activities, impacts to the Bighorn River fisheries could result. Hence, strict procedural control during site preparation and construction activities is recommended to mitigate this potential impact.

Plant Operation and Maintenance (Including Ancillaries and Right-of-Ways). The stringent air emission control measures necessary primarily to comply with the Class I air quality PSD increment on the adjacent Northern Cheyenne Reservation as discussed in Section 4.6.1, drastically reduce SO_2 and particulate matter ground-level concentrations as well as other gaseous pollutants (H_2S, hydrocarbons, oxides of nitrogen, etc.) emanating from the proposed Crow synfuels plant, thereby minimizing potential damage to vegetation and, hence, to loss of wildife habitat and consequent reductions in wildlife populations both in the immediate area of Site 1 and along the ancillary water pipeline, access roads, and railroad rights-of-way corridors.

Similarly, the multilayer containment design for ponds containing possibly hazardous process liquid waste residues and the completely encapsulated clay-lined repository proposed for process solid waste disposal reduce the probability of uptake and accumulation of potentially toxic trace elements by wildlife. Additionally, open surface area of the ponds for liquid waste containment possibly could be minimized by reducing overall plant water requirements through more effective water management although no attempt was made to effect such reductions as they were not considered within the scope of work for this study. Reduced pond size decreases the likelihood of usage by migratory fowl and birds.

As previously discussed, proposed water requirements for plant operation and maintenance are estimated at 31 cfs (14,000 gpm). Water intake structures are proposed for location near the confluence of Two Leggins Creek and the Bighorn River (Figure 4.6.4-1). Although reductions of total instream flow in the Bighorn River are not expected to be significant (0.85 percent of average annual flow), site-specific water withdrawals should not result in a major impact to fishery resources. Potential fish losses due to impingement and entrainment at the water intake structures can be mitigated by proper design utilizing state-of-the art technology.

Corridor maintenance could result in further disruption and loss of habitat. The use of certain types of herbicides for corridor maintenance could result in potential toxic pollution of aquatic resources and should be avoided. Strict corridor maintenance procedures will be required to reduce the foregoing potentially adverse impacts.

4.6.4.2 Site 23

Plant Construction (Including Ancillaries). Preliminary plant layout indicates the approximately 1,440 acres will be required for Site 23. Plant boundaries tentatively encompass approximately 750 acres. Approximately 60 miles of pipeline will be required to transport needed water supplies to the plant site. Access roads as proposed will cover approximately 27 miles. Total surface acres required for both the access roads and pipeline is about 690 acres. Therefore, a total of 1,440 acres of wildlife habitat could be considered lost for the duration of the project.

The candidate plant site lies within a major pronghorn antelope winter range with plant boundaries overlapping or lying directly adjacent to critical-use areas (see

Figure 4.1.6-5). Construction activities could seriously impact these animals depending on the timing of activities. Movements of antelope from the lower portions of the winter range to the upper northwest sections could be disrupted. Birthing activities of pronghorn antelope and mule deer could also be disrupted resulting in lowered reproductive success. Golden eagles and prairie falcons are also known to nest within close proximity to the plant site; therefore, any disturbance during nesting season could result in abandonment of the area.

Although activities associated with access road and pipeline construction will be temporary, impacts could be significant if these activities transpire during critical life-cycle periods for indigent wildlife. Access roads and pipelines will cross known mule deer, white-tailed deer, and elk ranges (Figure 4.6.4-2) thus causing disturbances during construction activities. Uncontrolled access and activities could result in poaching and further harassments, particularly in more remote areas.

Increased siltation of Youngs and Dry creeks and, consequently, the Tongue River could occur if measures are not taken to minimize or contain runoff from disturbed sites by properly conducted site preparation and construction procedures. The already low populations of brook trout in the upper reaches of Youngs and Dry creeks could be essentially eliminated if excessive siltation occurs. Likewise, the Owl Creek and the Little Bighorn River fisheries could be impacted if excessive siltation occurs.

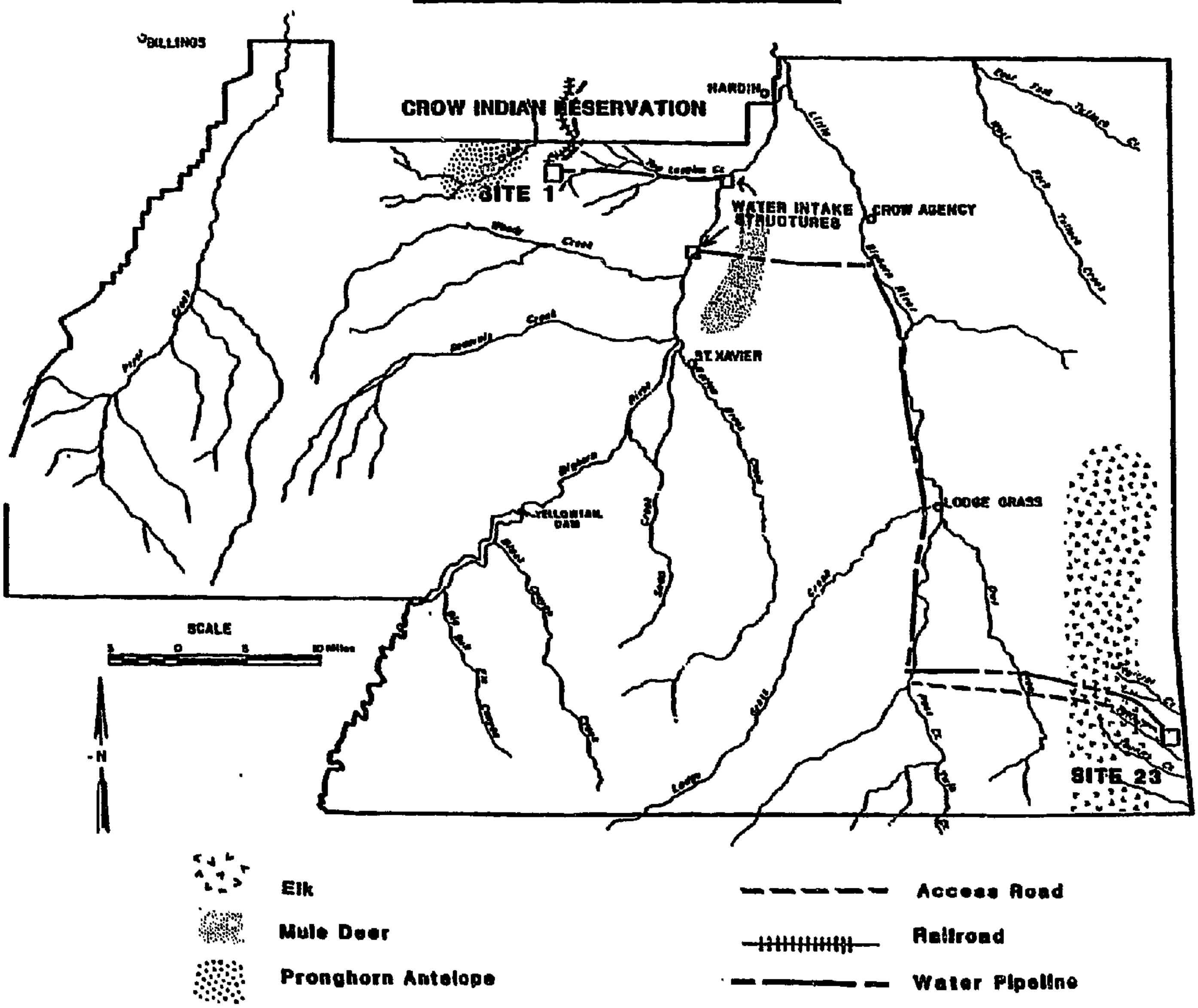
Plant Operation and Maintenance (Including Ancillaries and Right-of-Ways). Noise associated with plant operation will continue for the life of the plant thus causing abandonment of the area by species with lower tolerances. Although some species may gradually repopulate, pronghorn antelope, sharp-tailed grouse, and sage grouse may abandon permanently. Nesting by several important raptors has been documented within the general area and permanent disturbances will likely cause abandonment.

Water for plant operation and maintenance will be withdrawn from the Bighorn River downstream from the confluence of Woody Creek and piped nearly 60 miles to the

<u>FIGURE 4.6.4-2</u>

<u>IMPORTANT BIG GAME USE AREAS BISECTED</u>

<u>BY PROPOSED CORRIDORS (SITE 23)</u>



plant site (Figure 4.6.4-1). Site-specific water withdrawals could impact fishery resources if intake structures are not properly designed as previously discussed with respect to Site 1.

4.6.5 Utility Corridors: Environmental Considerations

A general summary of typical impacts associated with utility corridors is presented in Table 4.6.5-1. Potential impacts associated with the various utility corridors obviously depend upon:

- type of utility;
- length of corridor;
- geographic location;
- planning and design details (including corridor selection);
- construction practices; and
- maintenance practices.

Since the rights-of-way associated with utility corridors can often comprise a significant amount of land area, there is extensive potential for wildlife habitat within these corridors as cited in prior sections of this report.

Some of the major concerns with ecological impacts of utility line corridors center on the management of the corridor. Herbicides were used extensively in the past to maintain a clear right-of-way. This practice resulted in the loss of vegetation and, hence, carrying capacity. On the other hand, the areas relatively clear of overstory vegetation frequently have a good diversity of shrub vegetation and other understory vegetation. This, in turn, maintains a more diverse food web than the forest alone.

TABLE 4.6.5-1.

SUMMARY OF POTENTIAL IMPACTS COMMONLY ASSOCIATED WITH THE CONSTRUCTION, OPERATION AND MAINTENANCE OF UTILITY CORRIDORS

Project Phase	Potential Impacts
Construction	Changes in surficial geology. Changes in hydrology. Erosion of soil. Effects on water quality. Loss of vegetation. Loss and/or disruption of wildlife habitat. Disruption of wildlife.
Operation and Maintenance	Use of pesticide may cause loss of vegetation and wildlife habitat. Use of pesticides may cause effects on water quality and aquatic community. Maintenance of cleared right-of-way may also increase species diversity. Access roads may cause erosion channels. Effects (largely unknown) on biota associated with very high voltages. Collisions of birds with utility towers and power lines.

Thus, the cleared right-of-way maintains an ecotone and introduces increased species diversity along the corridor. Therefore, the details of management of the utility corridor will determine the potential impacts on the regional ecosystem. There is a current tendency to restrict the use of herbicides and, thus, allow the natural process of ecological succession to occur within the corridor.

The construction of large pipelines can cause significant effects on the abiotic and biotic components of the corridor. The relatively deep excavation will disrupt the surficial geology, hydrology, and vegetation. Drainage ditches and access roads are also frequently necessary. Long pipelines require extensive construction camps. Extensive noise from the construction equipment and from blasting may cause as much disruption of wildlife as is frequently experienced with highway construction.

One of the important aspects of the construction of long pipelines from the biological viewpoint is the potential to traverse many types of habitats. As with highways, the probability of open fields, agricultural land, forested areas, streams, and wetlands increases with the length of the corridor. Thus, the complexity of the ecosystem analyses increase. Also, the probability of specialized or even critical habitat increase. Threatened and endangered species become a highly predictable concern with such projects. Very long corridors, such as this Site 23 scenario, may even traverse several biomes and, thus, a whole new set of challenges arise, because it may be necessary for specialized teams of experts to work on the biological assessments.

The maintenance of pipelines generally poses few problems along the majority of the corridor. Access to pump and valve facilities are required. But the majority of the corridor can be revegetated and various land-use alternatives may be exercised, including agriculture. However, the details will depend upon right-of-way agreements and other legal constraints. From the biological perspective alone, the potential to maintain a viable biotic community does exist after the construction phase.

Although the construction activities for transmission lines are not as disruptive of the physical terrain as those associated with access roads and pipelines, the placement of poles and towers requires some excavation, but the areal extent is relatively small. Some clearing and grubbing takes place, but this is dependent upon the terrain and transmission systems. The hauling of construction materials and the establishment of the construction camp generally may cause localized disturbance of flora and fauna. Some drainage ditches are frequently necessary. However, the amount of erosion is generally small compared to highway construction. Nevertheless, short-term disruption of aquatic and terrestrial wildlife is common.

Another area of potential biological concern are the physical phenomena associated with high voltage electric transmission line, including (1) noise, (2) corona effects, (3) electric fields, and (4) magnetic fields. At relatively lower voltages (less than 500 kV), there probably is an insignificant effect on wildlife behavior. However, the influence of the higher voltages on plants and animals is currently ill-defined.

Perhaps the most important mitigation measure for utility corridors centers on the selection of the corridor. Related to general corridor selection is the actual location of the alignment. The alignment should consider terrain features such as slopes, canyons, natural benches, and other topographic details. The general objectives are to minimize the cut, fill, and clearing operations for the right-of-way and access roads. These measures will in turn minimize erosion, changes in hydrology, and loss of vegetation. Over the longer term, the most important mitigation measure is to maintain the vegetation and, thus, the carrying capacity for wildlife.

Should maintenance of pipeline corridors be required, further disturbances and loss of habitat may occur. The use of herbicides for corridor maintenance could contribute to toxic pollution of aquatic resources and should be avoided as discussed previously. However, since the length of the corridor is considerably greater for Site 23, the potential impact would be concomitantly more extensive for Site 23.

4.6.6 Preliminary Cultural Resources Impact Assessment

Since the extent of cultural resources for much of the Crow Reservation, including the proposed candidate plant siting areas of impact, is largely unknown, it becomes difficult to adequately assess the cultural or archaeological impacts of the proposed project. However, cultural resources are vulnerable to impacts from surface and subsurface disturbance and from intrusion into previous relatively inaccessible and remote areas.

Construction activities could totally destroy buried deposits if adequate and required archaeological clearances are not obtained. Increased human access to previously remote areas could enhance the potential for vandalism and theft at cultural sites. Valuable information important to the understanding of prehistoric and historic events could be lost or destroyed. Religious and sacred sites important to the Crow tradition could also be impacted. Compliance with all tribal, state and federal rules, regulations, codes, orders, and proclamations will be required to adequately mitigate any adverse effects on this potentially significant resource.

4.6.7 Potential Impacts From Radioactive Trace Elements in Coal

There are three major distinct chains of radioactive elements essentially contained in all coals: (1) the uranium series which originates with uranium-238; (2) the thorium series which originates with thorium-232; and (3) the actinium series which originates with uranium-235. These three elements decay into a number of radioactive species which are important from a radiotoxic standpoint. Those elements of most importance include thorium-230, radium-226, radon-222, lead-210, polonium-210, radium-228, thorium-228, and radon-220.

The concentrations of elements within these decay chains may vary significantly from one coal to the next. It has been observed that Eastern coals generally contain about 1.6 ppm uranium and 2.0 ppm thorium although individual values may vary considerably (Gluskoter, 1977). Western coals have been reported to contain much higher concentrations ranging from 10 ppm to greater than 5000 ppm (BMI, 1977). The concentrations of uranium-238, uranium-235, and thorium-232 naturally affect the levels of the radionuclides within the three chains as they are all generally considered to be in secular equilibrium with each element within their respective chains for purposes of preliminary analysis.

It has been observed in coal and SRC processing operations that radionuclides are most likely to be found in solid residues and flyash (LASL, 1976). Smaller quantities may be found in gaseous and liquid wastes. These operations tend to concentrate the radionuclides thereby possibly posng some occupational health hazards which should be evaluated more thoroughly if the Crow synfuels project proceeds beyond the state of the feasibility study. (Reference 85).

The trace concentrations of uranium and thorium in the Westmoreland coal are 1.43 ppm and 3.61 ppm, respectively, as previously presented in Section 4.5 of this report. Similarly, the trace quantities of uranium and thorium in the Shell coal supply are 1.45 ppm for uranium and 1.28 ppm for thorium.

The quantification of estimates for stack emissions of trace elements in particulate matter, including uranium and thorium, are presented in Table 4.5.1-2 of Section 4.5 for Case I and II design scenarios employing the Westmoreland coal feed and the Case II design scenario utilizing Shell coal. The Case II residuals analysis indicates that approximately 61 lb/yr of uranium and 135 lb/yr of thorium would be released to the atmosphere as particulate employing the Westmoreland coal supply. Similarly, the Case II analysis counterpart assuming the Shell coal feed shows particulate emissions of 119 lb/yr of uranium and 92 lb/yr of thorium.

Application of the VALLEY air dispersion model, as in the previously discussed modeling analysis Section 4.6.1 of this report, and utilization of the foregoing quantities of uranium and thorium particulates as source terms results in maximum concentrations at selected receptor locations of much less than 0.1 ug/m^3 for both U-238 and Th-232 encompassing all the aforementioned worst-case design scenarios. Utilizing data obtained from Georgia Power Company's Plant Mitchell and other coal-fired power plants, Hittman Associates, Inc. (1978) has estimated that 0.2 ug/m^3 may be discharged from a power plant to the atmosphere which is lower than the allowed general public dose radiation level of 7.0 ug/m^3. This led them to conclude that radionuclide levels from coal-fired power plants to don appear to pose any significant problem from the radiotoxic standpoint.

However, several groups (LASL, 1976) have estimated that approximately 90 percent of the uranium content in the coal feed for power plant combustion process terminates in the ash residues. (References 34, 75).

Assuming a 90 percent retention of the uranium in the combined FGD sludge, boiler ash residues, and gasifier ash residues, the preliminary annual estimates of activities for U-238 and Ra-226 retained in the solid waste disposal facility are presented in Table 4.6.7-1 for the aforementioned design case scenarios utilizing both the Westmoreland and Shell coal supplies. Table 4.6.7-1 illustrates that a maximum of approximately 4.6 curies/yr due to U-238 would accumulate in the solid wastes for the worst-case Case II design scenarios. It is recommended that the potential radionuclide inventories, particularly in the solid wastes, be more thoroughly investigated if the Crow Synfuels project should proceed beyond the stage of this feasibility study.

TABLE 4.6.7-1

CROW COAL GASIFICATION PLANT,

250 MM SCF/D SNG PRODUCTION:

URANIUM-238 AND RADIUM-226 ACTIVITIES IN SOLIDS RESIDUALS

PRELIMINARY ANNUAL ESTIMATES

(Curies per year)

Constituent	Westmoreland Coal Case I	Westmoreland Coal Case II	Shell Coal Case II
U-238	3.43	4.68	4.64
Ra-226[a]	4.88E-05	6.66E-05	6.60E-05

[a]Assumes a Ra-226 mean specific activity of 4.77 pCi/gm for coals in the Rocky Mountain Province.

4.7 ENVIRONMENTAL MONITORING REQUIREMENTS

Requirements for detailed, site-specific baseline environmental monitoring data constitute an essential facet of the Crow synfuels feasibility study. The environmental baseline data developed and discussed in considerable detail in Section 4.1 must be substantiated at the final selected site location for the Crow synfuels project. As indicated in the Scope of Work, Section 3.0, primary emphasis has been placed upon the preoperational air and water quality monitoring program requirements since the air monitoring program, in particular, currently requires one year of monitoring data prior to the initiation of the environmental permitting process for the project as previously discussed in Sections 4.3 and 4.4 and illustrated in Figures 4.3-1 and 4.4-1. Although any discussion of a preoperational environmental monitoring program must necessarily be somewhat generic in nature at the feasibility study stage of any project, the major measurement and analysis requirements are defined based upon the information derived as a result of this study and the current state-of-the-art technology base for environmental monitoring systems. No attempt has been made to generate detailed specifications for monitoring equipment or to recommend any specific vendor's products since to do so would be preemptive at this stage of the Crow synfuels project.

4.7.1 Air Monitoring Program

The air monitoring program must be designed to measure, on a continuous and/or discrete interval basis, ground-level concentrations of SO_2, NO_x, NO_2, HC, suspended and settleable particulate matter on a temporally concurrent basis with the following climatological/meteorological parameters: wind, wind direction, dewpoint (relative humidity), temperature, barometric pressure, atmospheric stability, evaporation rate, and precipitation.

The primary monitoring station location must be selected to be as representative as possible of the climatology and meteorology of the selected site for the Crow synfuels facility. The primary station should include an instrumented 100-meter meteorological tower which will provide the following information: two levels of windspeed and direction data (100-meter and 30-meter levels); ambient temperature (30-meter level); and two levels of dewpoint (100-meter and 30-meter levels). The remainder of the aforementioned air quality, climatology, and meteorology parameters will be measured by instrumentation located on the tower at or below the 30-meter level or on the surface level adjacent to the station.

The primary station shelter should be designed to assure appropriate control of both temperature and humidity since, in addition to various forms of instrumentation and ancillary equipment, the station will house the automated data acquisition systems to continuously record most of the foregoing parametric data with the exception of the passive sampling network. The passive sampling network should consist of 25 to 30 passive samplers of dustfall and sulfation plates for measurement of settleable particulates and sulfation rate determinations on a monthly basis.

Additionally, the suspended particulate samplers would probably not be incorporated into the automated data acquisition system since the particulate matter would be analyzed on a 24-hour to 1-week basis, depending upon ambient TSP background concentrations.

Several additional mobile air monitoring stations might be required depending on terrain considerations and the degree of variability of the climatology and meteorology of the selected plant site area. The mobile stations, if required, would serve to correlate and verify the data analysis derived from the data collected and stored at the primary station.

Provisions for site-specific upper air meteorological studies should be made to supplement the aforementioned near-surface measurements particularly with respect to the collection of atmospheric stability and mixing height data and long-range (regional) transport characteristics of potential gaseous and particulate pollutants. Thus, a minimum of one site located near the primary station should be adapted for pibal balloon and/or balloon-sonde observations on at least a twice-daily basis and temporally concurrent with the continuous measurements of the previously specified air quality, climatological, and meteorological parameters over a minimum record interval of one year.

Visibility measurements are not required for the nonmandatory Class I air quality-designated Northern Cheyenne Reservation at this time. Therefore, the additional equipment (integrating nepholometers, spectrophotometers, fine particulate samplers, etc.) necessary to define the atmospheric optics of the facility siting area in terms of possible visibility degradation, does not have to be included in present preoperational air quality monitoring program planning activities.

Since the automated data acquisition archives the majority of the measured parameters, the systems should contain provisions for statistically averaging selected portions of the collected data on an hourly, 3-hour, monthly, seasonally, and yearly basis as required. For example, routine data analytical procedures should include:

Meteorological Analyses

Frequency distributions and joint frequency distributions.
Mean wind direction and speed.
Resultant wind direction and speed.
Wind persistence.
Diurnal distributions.
24-hour resultant wind.
Two-station wind correlations.
Stability categorizations.

Pollutant Analyses

Diurnal averages.
Daily averages—arithmetic.
Geometric means.
Cumulative probability distributions.

Running means.

Seasonal and annual averages.

Joint frequencies with meteorological parameters.

Comparisons with applicable state, tribal, and federal standards.

The importance of strict quality assurance procedures administered by properly trained personnel cannot be overemphasized, since a high percentage of data recovery is the prime objective of any monitoring program.

The operational air monitoring program will be predicated to a large degree on the results of the data analysis derived from the foregoing preoperational program. Therefore, it is possible that a number of the measured parameters can be excluded from regulatory monitoring requirements once plant operation is sanctioned as a result of the environmental permitting process.

4.7.2 Water Monitoring Program

Although the water monitoring program is not as critical in terms of scheduling requirements for the environmental permitting process for the Crow synfuels project, both surface water and groundwater baseline environmental monitoring programs should be initiated concurrently with the baseline air monitoring program once the final facility site selection is made and the decision to proceed to the next phase of the project is affected.

4.7.3 Surface Water Monitoring Program

The definition of the surface hydrologic regime is an important part of the initial baseline program. The initial phase of this task will involve a detailed hydrologic reconnaissance to inventory location and to describe size, shape, and channel characteristics of any water bodies and streams within a 5-mile radius of the proposed facility siting area boundary. During this inventory, sites suitable for the monitoring program should be selected and springs and seep areas should be located.

Since the objective of the surface water hydrology program is to define flow characteristics and water quality currently existing on or near the site, monitoring stations for continuous flow and collection of grab samples for water quality determinations will be necessary. This monitoring will be conducted on streams that could be potentially affected by the operation of the Crow synfuels plant.

Each of the above stream station(s) would have an appropriate flow control structure and a continuous site recorder installed and monitored for at least one year. These stations would not be maintained during the winter months due to difficulty of maintenance and probable lack of flow. However, the stations would be visited on a monthly basis, if possible during the winter, for spot flow measurements.

The water quality characteristics would be monitored in accordance with guidelines from the various government agencies involved. This will entail, at a minimum, quarterly sampling at each of the stations (where flow is present) according to the procedures and for the paramters listed in Table 4.7.3-1. As a part of the surface water preoperational (baseline) monitoring program, an inventory of springs and seeps should be conducted, if applicable, within a radius of 5 miles of the proposed plant siting area. Once the Crow synfuels plant attains normal operational status, the above surface water sampling frequency could be reduced to a semi-annual basis.

4.7.4 Groundwater Monitoring Program

In order to meet the various regulatory requirements, aquifers that may be potentially affected by the operation of the Crow synfuels plant and the ancillary process liquid and solid waste disposal facilities must be determined. This requires definition of the thickness, areal extent, recharge and discharge areas, direction and rate of movement, permeability, and other pertinent characteristics.

TABLE 4.7.3-1

SURFACE WATER QUALITY SAMPLING AND MEASUREMENT PROCEDURES: BASELINE MONITORING PROGRAM

Field Measurements:

pH (reported to nearest 0.1 pH unit)
Temperature (^{o}C)
Conductivity (micromhos/cm corrected at $25^{o}C$)

Laboratory Measurements[a]:

H_2SO_4 should be used as the sample preservative for:	HNO_3 should be used as the sample preservative for:
Ammonia (as N)	Aluminum (Al)
Nitrate (NO_3) as N or	Arsenic (As)
Total Nitrite (NO_2)/Nitrate	Barium (Ba)
(NO_3) as N	Cadmium (Cd)
	Chromium (Ca)
No preservative should be used for:	Copper (Cu)
	Iron (Fe)
	Lead (Pb)
Bicarbonate (HCO_3)[b]	Manganese (Mn)
Carbonate (CO_3)	Mercury (Hg)
Calcium (Ca^{++})[c]	Nickel (Ni)
Chloride (Cl^-)	Selenium (Se)
Boron (B)	Zinc (Zn)
Flouride (F^-)	Molybdenum (Mo)
Magnesium (Mg^{++})	Vanadium (V)
Potassium (K^+)	Uranium (U)
Sodium (Na^+)[c]	Radium (Ra-226)
Sulfate (SO_4)	

[a] Water samples should be field-filtered using a 0.45-micron membrane filter if dissolved concentrations are to be reported.
[b] Total alkalinity may be determined in the field.
[c] EPA recommends that this ion should be preserved using HNO_3.

After a thorough review of the existing groundwater hydrology baseline data base for the proposed facility siting area, an initial hydrologic test hole drilling site would be selected. The preferred method of drilling this hole would be air or air mist; however, the drilling program would be based on review of site-specific conditions. The advantage of drilling with air is that productive aquifer intervals can be directly detected through monitoring quality and quantity of fluid returns during drilling. Recovery tests can be conducted at different intervals while drilling to estimate the transmissivity of saturated units penetrated by the borehole. If large quantities of water are encountered, it may be necessary to modify the drilling procedure by using a stiff foam. Appropriate borehole hydrologic tests could still be conducted to aid in aquifer definition. Additionally, a suite of appropriate borehole hydrologic tests could still be conducted to aid in aquifer definition. After completion of drilling of the pilot hole, a suite of geophysical logs would be run from the following list.

Resistivity	Temperature
Induction	Differential temperature
Sonic	Spinner

After evaluation of data collected, a decision would be made on the completion of an initial hole. If completed, a piezometer network would then be designed and installed to facilitate water level measurement, collection of water quality samples, and aquifer testing. A pumping test of at least 48-hours duration would be conducted while monitoring level response of surrounding piezometers in order to quantify hydrodynamic characteristics of the monitored aquifer.

Water levels in all the selected monitoring drill holes or wells would be monitored on a quarterly basis in order to quantify seasonal fluctuations. Water quality samples representative of each defined aquifer unit would be collected on at least a semiannual basis for a minimum of one year during the preoperational monitoring program and analyzed for the constituents presented in Table 4.7.4-1.

The number of monitoring wells required for the proposed facility siting area would be dependent on the subsurface geohydrologic characteristics of the siting area.

TABLE 4.7.4-1
HYDROLOGIC FIELD MEASUREMENTS: CHEMICAL PARAMETERS

eH
pH
Temperature
Specific conductance
Total alkalinity
Ammonia (as N)
Total Nitrate (NO_2^-)/Nitrate (N_3^-) as N
Bicarbonate (HCO_3^-)
Carbonate ($CO_3^{=}$)
Chloride (Cl^-)
Boron (B)
Fluoride (F^-)
Sulfate ($SO_4^{=}$)
Aluminum (Al)
Arsenic (As)
Cadmium (Cd)
Chromium (Cr)
Copper (Cu)
Iron (Fe)
Lead (Pb)
Magnesium (Mg)
Manganese (Mn)
Mercury (Hg)
Nickel (Ni)
Potassium (K)
Selenium (Se)
Sodium (Na)
Zinc (Zn)
Molybdenum (Mo)
Vanadium (V)

Installation of a minimum of six piezometers should be effected into the first aquifer encountered. Four of these piezometers would be installed and developed in order to confirm the direction of groundwater flow. Once this direction is determined, two additional piezometers would be installed on the downgradient side of the facility site. At least one of the monitoring wells should have either packer tests or falling-head permeability tests run in the unsaturated zone between the surface and the first aquifer. This will allow projection of the potential rate of possible seepage losses from the liquid waste ponding areas.

If a minemouth site is selected for the Crow synfuels plant, an evaluation of potential mine water inflow to the solids waste disposal facility siting area should be conducted in order to determine potential discharge quantities that may need to be disposed.

Additionally, an inventory of current groundwater appropriation within a 10-mile radius of the eventual Crow synfuels facility siting area should be conducted. This inventory will be based on a search of the water rights files from the BIA Area Office. If any wells are located within a 2-mile radius of the aforementioned facility siting area, water samples should be collected on a semiannual basis for analysis of the constituents listed in Table 4.7.4-1.

SECTION 5.0
CONCLUSIONS AND RECOMMENDATIONS

It was recognized at the onset of the feasibility study that initially the salient environmental constraint would be selection of candidate sites for a Crow synfuels plant capable of producing 250 MM SCF/D of SNG that would be in compliance with the very stringent Class I air quality standards for SO_2 and particulate matter PSD increments on the adjacent Northern Cheyenne Reservation. Consequently, the air quality dispersion modeling analysis of eight possible candidate plant sites entailed utilization of the VALLEY model in the rural, short-term, complex terrain mode, since the program can be invoked as an early predictive screening technique without the input data requirement for currently unavailable, site-specific climatological/meteorological data in areas with irregular terrain features; i.e., plant siting opportunities on the Crow Reservation and potentially sensitive pollutant receptor locations on the nearby Northern Cheyenne Reservation. The preliminary screening analysis narrowed the number of sites to be considered for more detailed trade-off analysis in the overall siting evaluation study (Volume V) to four candidate sites based upon current (1985 to 1990) BACT limitations for plant SO_2 emission control efficiencies of less than or equal to 90 percent, vent gas incinerator SO_2 emission control efficiencies of less than or equal to 96 percent, and ESP particulate matter removal efficiencies of 99.7 percent. Two of the candidates, Sites 1 and 1A, are located in the west-central area of the Crow Reservation. The other two candidate sites, 20 and 23, are located in the southeastern section of the reservation. Additional siting trade-off studies as discussed in Volume V further reduced the siting candidates to Site 1 and Site 23, thereby facilitating a more definitive compilation, evaluation, and assessment of pertinent, presently available environmental baseline information in those affected areas of the Crow Reservation germane to the overall evaluation of the synfuels final candidate plant site selections.

Therefore, the final assemblage of environmental baseline data in this report includes pertinent information on the Crow Reservation in the following major areas: climatology and air quality, surface water and groundwater quantities and quality; physiography and land use; soils and vegetation; wildlife resources; geology; seismology; and cultural resources (archaeology). The foregoing environmental baseline information provided the natural background for the subsequent assessment of potentially adverse environmental impacts at Sites 1 and 23 based on two selected plant design scenarios for the proposed Crow synfuels plant.

Recalling that the most stringent environmental impacts for this feasibility study are imposed by the Class I air quality designation for the adjacent Northern Cheyenne Reservation, emphasis was placed upon a more detailed evaluation of design emission control requirements for mitigating these potential air quality impacts.

Since the basic process design developed by Fluor during the course of this study, as discussed in Volume II, is predicated upon an SNG production rate of 125 MM SCF/D, the aforementioned design scenarios were upgraded to reflect an ultimate plant production rate of 250 MM SCF/D in order to verify previous compliance of the two primary candidate sites with air quality Class I PSD increments on the nearby Northern Cheyenne Reservation, derived from the prior, early preliminary air quality screening analysis, also predicated on an SNG production rate of 250 MM SCF/D utilizing preliminary plant process design estimates for both Westmoreland and Shell coal feeds.

In addition to confirming compliance with SO_2 and particulate matter Class I PSD increments, the second phase of the air dispersion modeling analysis investigated the implications of the GEP stack height regulations recently promulgated by EPA in terms of the sensitivity of SO_2 emission control efficiencies to plant physical stack height. Emphasis was placed upon SO_2 emission control efficiencies for the boiler plant for several reasons. The plant design synthesis indicated achievable SO_2 emission control efficiencies of greater than 98 percent for the Lurgi gasification plant, while state-of-the-art (BACT) technology for FGD systems for coal-fired boiler plants is presently vendor guaranteed for less than or equal to 90 percent SO_2

emission control efficiencies. Additionally, the impositions of 99.4 to 99.7 percent removal efficiency for the ESP in the design scenarios to control particulate emissions within the EPA regulatory requirements for NSPS of 0.03 lb/MBtu of heat released, drastically reduces the particulate emissions. Reduced emission loadings coupled with the higher allowable 24-hour PSD increment of 10 ug/m^3 for particulate matter as compared to its SO_2 counterpart of 5 ug/m^3, has precluded any serious air quality impacts due to plant particulate emissions at either Site 1 or Site 23 for the two design case scenarios evaluated in this study.

Since the Case I plant design scenario assumes a production rate of 250 MM SCF/D SNG and generation of sufficient power for internal requirements only and the Case II plant design scenario produces 250 MM SCF/D of SNG utilizing the excess fines (40 percent) in the coal feed to produce additional marketable electrical power, more stringent SO_2 emission control is necessary to preclude violations of the Class I air quality regulations for the Case II design scenario.

The sensitivity analysis performed for both Case I and Case II design scenarios at Site 1 demonstrate that any physical stack height greater than or equal to 620 feet would meet the 24-hour SO_2 Class I PSD requirement for Case II, assuming baseline emission control efficiencies of 90 percent and 98.7 percent for boiler and vent gas incinerator emissions, respectively, and utilizing a Westmoreland coal supply. The Case I design scenario for a Westmoreland coal feed is relatively insensitive to change in physical stack height over the range of 350 to 650 feet and would achieve Class I PSD compliance for SO_2 emissions with the assumed baseline control efficiencies (90 percent) over that range of values. Although it is not anticipated, the use of the Shell coal supply at Site 1 for the Case II design scenario employing baseline SO_2 emission control efficiencies of 84 percent and 98.7 percent for boiler and vent gas emissions, respectively, results in a somewhat lower physical stack height than for the Case II design for a Westmoreland coal feed. The Shell Case II design scenario requires a physical stack height greater than or equal to 485 feet in order to comply with the 24-hour SO_2 Class I PSD increment.

A review of possible vendors for FGD systems has indicated that one potential supplier has quoted an achievable upper limit (BACT) of 93.4 percent SO_2 emission control efficiency in the assumed 1985 to 1990 time frame for the final design and construction phase of this project. Upward adjustment of 90 percent SO_2 emission control efficiency to 93.4 percent for boiler emissions would effect a reduction of 100 feet in the minimum physical stack height requirement; i.e., from 620 feet to 520 feet for plant designs utilizing Westmoreland coal supplies at candidate Site 1. The above result assumes that the baseline SO_2 emission control efficiency for the vent gas incinerator retains a baseline value of 98.6 percent From previously discussed results, it has been shown that the Case II design scenario utilizing the Westmoreland coal supply establishes a possible future attainable limit for SO_2 Class I PSD compliance at Site 1 of 93.4 percent SO_2 emission control efficiency for the boiler emissions and a physical stack height of 520 feet. Therefore, assuming the slightly more conservative value of 525 feet for the plant physical stack height, a greater than or equal to 93.4 percent boiler SO_2 emission control efficiency would be required to comply with the 24-hour SO_2 Class I PSD increment. For the same set of initial assumptions, it is shown that greater than or equal to 84.5 percent SO_2 boiler emission control efficieny would be required for Class I PSD for the Case I design at Site 1 utilizing Westmoreland coal. Similarly, the use of Shell coal for the Case II design scenario would, in turn, necessitate greater than or equal to 82 percent SO_2 boiler emission control efficiency at Site 1 to achieve the Class I PSD compliance.

The assumption of the de minimus GEP stack height regulation crediting a 213-foot (65m) allowance for modeling purposes does not affect any serious design constraints at Site 23 for the Case II scenario employing the Shell coal supply. Thus, an actual physical stack height of 213 feet could be utilized for this scenario at Site 23 provided greater than or equal to 76.3 percent boiler SO_2 emission control efficiency is maintained. Since the currently attainable or BACT baseline for boiler SO_2 emission control for the Case II design utilizing the Shell coal supply is 84 percent, it can be concluded that SO_2 Class I PSD compliance at Site 23 does not present a major potential environmental air quality impact for currently envisioned plant design scenarios.

It must be emphasized that the VALLEY model used for the predictive air quality modeling analyses in this feasibility study assumes conservative values for surface wind speed (2.5 m/sec), atmospheric stability (Pasquill-Gifford Category F), and equal probability for surface wind direction in all calculations as mandated by present EPA guidelines. When site-specific, hourly surface wind data and a minimum of twice-daily upper wind data are available, as recommended for the proposed preoperational air monitoring program requirements in this study, it is further recommended that a more sophisticated air dispersion model, capable of utilizing the aforementioned detailed climatological/meteorological data, be employed to reduce the aforementioned degree of inherent conservatism present in the results for this study. A more detailed air dispersion modeling analysis could possibly effect a reduction in the air emission control requirements for the final engineering design of the Crow synfuels plant if this project proceeds to that stage of development.

Additional mitigation measures have been proposed for the plant emission control system in the form of special burners to limit both emissions of gaseous hydrocarbons and oxides of nitrogen, thereby reducing the probability of major visibility degradation and potentially adverse atmospheric chemical interactions which would result in possibly significant air quality impacts that could ultimately result in potential, long-range regional air quality impacts.

The proposed water requirements for the upgraded 250 MM SCF/D SNG Crow synfuels plant are presently estimated at 14,000 gpm. Since the Yellowtail Reservoir (Bighorn Lake) and the Bighorn River currently constitute the only regulated supply of water on the reservation that will satisfy the aforementioned design requirements for either Site 1 or Site 23 on a continuing basis, the withdrawal of approximately 20,500 ac-ft/yr represents the only potential environmental impact from the proposed plan operation of the surface water and groundwater resources with respect to overall reservation water budget or inventories.

The other major drainages on the Crow Reservation—the Little Bighorn River and Pryor Creek—are presently unregulated and, hence, could not meet the aforementioned plant requirements during the minimum or low natural discharge rates occurring on a yearly seasonal basis.

It is recommended that if Site 23 is eventually selected as the plant site, the possibility of utilizing the Tongue River east of the reservation boundaries as a water supply source should be investigated. The use of a Tongue River water supply would reduce the amount of disturbed land acreage resulting from installation of the water supply lines from Yellowtail Reservoir or Bighorn River to Site 23. Hence, this could lessen both impacts to wildlife resources and native vegetation on the reservation.

Potential adverse water quality impacts to the Crow Reservation and the surrounding environs from the operation of the proposed Crow coal gasification plant are closely interrelated to the properly implemented mitigation of the liquids and solids process waste residues, since the engineering design of the facility is predicated upon zero liquid discharge; i.e., having no direct discharge of liquid waste effluents to surface water or groundwaters within the areas of the two selected candidate sites, Site 1 and Site 23. Hence, the major mitigation measures to preclude potential water quality impacts evolve quite naturally around the basic design of the synfuels plant process water management system regardless of the siting area.

The capability of water soluble ions or compounds to migrate or be transported externally from the immediate area of either plant site is dependent on (1) their increased mobility in liquid (aqueous) state and (2) a continuous transport linkage, the liquid pathway in this instance, to an area of potential environmental impact.

Therefore, the ancillary containment features incorporated into the design of the external liquid-solid and solid process waste effluents system constitute the primary mitigation measure necessary to prevent possible liquid contaminant migration into either surface waters or groundwaters. Thus, the design philosophy of mitigation by containment either eliminates or minimizes one of the two conditions necessary to produce the contaminant transfer mechanism.

All water and process liquid waste effluents for the Crow synfuels plant are stored in a series of ponds located within the completely fenced plant siting area, thereby precluding inadvertent entry by ambulatory wildlife.

The largest of the ponds and the recipient of the majority of potentially hazardous process liquid wastes—the solar evaporation pond—effectively incorporates a multilayer containment barrier composed of two relatively impervious lining materials, HDPE and clay.

The other small repositories of possibly hazardous liquid waste effluents—the wastewater equalization pond, the treated effluent pond, the diversion box and pond, and the oily stormwater pond—also incorporate the foregoing lining system design.

Additional mitigation measures incorporated in the pond design include design provisions for adequate freeboard and pond embankment side slope to preclude potential surface runoff of the stored, liquid waste effluents as a consequence of inadvertent natural occurrences such as tornadoes, heavy storms, or floods. Provisions for leakage detection are also included in pond design for all the aforementioned possibly hazardous liquid waste storage repositories if the integrity of the lining system is circumvented for any reason. The leakage detection system for the ponds is designed to allow plant operators a means of detecting any failures in the foregoing pond lining system and adequate time to employ corrective measures prior to the development of a potentially adverse environmental water quality impact.

Thus, it may be concluded that, under normal plant operating conditions and barring the occurrence of any catastrophic natural events (earthquakes, floods, tornadoes, etc.), the foregoing engineered containment design of liquid waste repositories for the Crow synfuels plant should prevent any major potentially adverse environmental impacts to the water quality of the Crow Reservation and the area adjacent to the reservation.

Although no attempt was made in this feasibility study to minimize the volume of liquid wastes and, consequently, the liquid surface areas of the waste ponds, it is recommended that this factor be more thoroughly evaluated prior to the completion of the final engineering design for the facility. In addition to reducing plant water requirements, minimal pond areas are less likely to attract migratory wildlife, thereby reducing the possibility of this impact.

Since a detailed ion material balance of possibly deleterious liquid waste effluents was considered beyond the scope of work for this feasibility study, it is recommended that this analysis be effected prior to the final engineering design of the facility for two primary reasons. The process liquid waste residues must be more definitively characterized in order to assess their long-term compatibility with the aforementioned liner materials, especially in terms of permeability. Additionally, in the unlikely event that the liquid wastes should breach the containment liners for any reason, the mobility of these liquids, even in trace quantities, should be assessed in the liquid-soil-groundwater environment of the plant siting area to provide additional mitigation measures, if deemed necessary, prior to the project construction phase.

A similar containment design approach to solid waste disposal has been developed for the proposed Crow synfuels plant. Since the quantities of solid wastes for a coal gasification plan are considerably more extensive than liquid wastes and the respositories are located external to the plant site boundaries, potentially more serious environmental water quality impacts than for liquid process waste residues could arise.

The Crow synfuels plant will produce a variety of solid wastes for disposal. The majority of the wastes consist of ash from the Lurgi coal gasification units, ash from the boilers, and sludge from the FGD unit. Other solid wastes from the plant include water treatment sludges, spent calalysts, and general plant refuse. It is recommended that general plant refuse will be at least qualitatively inspected prior to disposal at a local public waste disposal site to make certain that potentially hazardous process wastes are not inadvertently comingled. The quantification and environmental impact evaluation of the spent catalysts could not be adequately assessed in this feasibility study due to a lack of essential proprietary information concerning their physical and chemical properties.

The proposed solid waste disposal plan was developed by Fluor as the base case for this study and, therefore, is specified for Site 1 assuming the Westmoreland coal feed. The ash and other solid wastes will be stored adjacent to the synfuels plant battery limits since ash disposal at the existing Westmoreland Absaloka mine is not an economical option as discussed in greater detail in Volume V of this report. For the alternate Shell coal case at Site 23, the ash will be returned to the proposed Shell mine for disposal.

The volume requirements for solid waste disposal for the worst-case scenario, Case II, employing the Westmoreland coal at the proposed ultimate production rate of 250 MM SCF/D and producing additonal electrical power above that required for internal plant consumption, produce 0.977 million cubic yards of major solid waste effluents on an annual basis, or 24.4 million cubic yards of solid waste over a 25-year plant operating life. Similarly, the 125 MM SCF/D SNG Case IIA design scenario counterpart of Case II produces approximately one-half of the volume of solid wastes; i.e., 0.489 million cubic yards per year or 12.2 million cubic yards in the 25-year plan operating lifetime. About 55.48 per?ent of the solid waste volume for the design Case II and IIA scenario utilizing Westmoreland coal is the result of gasifier ash from the Lurgi process with ash and FGD sludges from the boiler operation representing about 28.25 percent and 16.27 percent, respectively, of the total solid waste volume both annually and cumulatively over 25 years. The design Case IA (125 MM SCF/D SNG) represents the lowest solid waste volume requirement for the designs using a Westmoreland coal feed. Solid waste volumes of 0.710 million cubic yards over 25 years are evidenced for design Case IA, with gasifier ash representing about 76.5 percent of the total solid waste volume. This result arises from the reduced requirement for the boilers, since the plant is designed to produce only enough power for internal facility needs.

A more realistic overall plan for long-term Crow synfuels plant operation is represented by the Case III scenarios which assume cumulative 25-year solid waste volumes based upon a 5-year operation at the Case IIA design level (125 MM SCF/D SNG) followed by a 20-year operation of the upgraded Case II plant design, since utilization of the excess coal fines to produce additional electrical power for sale to an electrical utility represents a more economically viable mode of plant operation than other options evaluated in this feasibility study as discussed in Volume II in considerably more detail.

The Case III scenarios result in a 25-year solid waste volume commitment of approximately 22 million cubic yards for the foregoing Case III scenario utilizing Westmoreland coal supply with about 55.4 percent of the total solid waste resulting from Lurgi gasifier ash. Case design scenarios IIA and II employing the Shell coal feed require considerably less solid waste disposal volume requirements due principally to lower ash content and also lower sulfur content of the Shell coal resulting in lower SO_2 emission control requirements (84 percent vs 90 percent) and, hence, less FGD sludge production for disposal.

Shell coal feed Cases IIA and II require solid waste disposal volumes of 0.282 million cubic yards and 0.565 million cubic yards, respectively, on an annual basis; and 7.562 million cubic yards and 14.125 million cubic yards, respectively, over an assumed 25-year plant operating period for the previously cited Shell coal design Cases IIA and II.

Unquenched ash samples from the Lurgi gasification tests of representative samples of both Westmoreland and Shell coals were subjected to two separate types of leachate tests. Analysis of leachate indicates that potential contaminant concentrations do not exceed the limits for hazardous wastes as currently defined by EPA. However, due to the technical complexity of the potential leachability of solids waste residues when acted upon by water at a land disposal area, the understanding of the possible long-term physico-chemical processes is presently incomplete. Therefore, it is recommended that a more thorough evaluation of the characteristics of these solid wastes be made prior to the construction phase of the proposed Crow synfuels project.

The solids waste disposal facility at Site 1 is designed for complete containment or isolation of the solid wastes by encapsulation with 5 feet of clay. Thus, any potential water quality impacts must be predicated upon either (1) transport of aqueous anions or cations derived from solubilized solid wastes through the clay liner; (2) fairly extensive fracturing of that liner due to some inadvertent catastrophic natural event such as an earthquake, flood, etc; or (3) improper liner preparation and construction procedures thereby creating the necessary transport pathway for possible solid waste contaminants to nearby surface waters or possible groundwater aquifers.

Since the clay liners will be specifically designed to have a permeability of 10^{-7} cm/sec or less, natural penetration through a 5-foot liner thickness as set forth in RCRA regulations would require more than 48 years under normal gravitational hydrostatic pressures for a possible aqueous contaminant to penetrate the liner. However, since significant attenuation of most possible contaminants would most certainly be affected during this time interval, it may concluded that potentially adverse water quality impacts to the area encompassing Site 1 are quite remote if the clay liner remains intact and provided that ancillary hydrostatic head forces are not present to increase the liner permeability.

The introduction of hydrostatic head forces can be precluded by assuring that neither the natural drainages or flooding conditions will result in drainage into the solid waste disposal facility area—a factor that has been accounted for in the previously discussed Site 1 solid waste disposal facility design.

Additionally, the natural geohydrologic environment of the Site 1 area lends itself to the mitigation of any potentially adverse water quality impacts from either solid or liquid process waste residues.

The geology of the Site 1 area indicates that stiff clays predominate over hard claystone bedrock at depths of 3 to 7 feet. The clays are silty, sandy, calcareous, and occasionally porous. The claystone bedrock is slightly sandy and contains scattered bentonitic clay lenses. The bedrock consists primarily of the Niobrara and Carlile shale members of the Colorado Group of the Cody Shale Formation of the Upper Cretaceous series. Preliminary test borings indicate that these clays and claystone bedrock expand when wetted indicating both relatively high natural impermeability and low, unsaturated interstitial pore volumes—natural conditions highly suited to the mitigation of potential aqueous contaminants.

Preliminary test borings in the Site 1 area have indicated no free water in any of the test holes to the maximum depth drilled of 20 feet. Hence, potential water quality impacts to groundwater aquifers by seepage should have little effect on any near-surface construction such as a solid waste disposal facility. Additionally, surface water drainage and evaporation should be limited to the overburden section above the clay cap of the disposal area.

Although the process solid wastes would most likely be returned to the proposed Shell mining area for disposal from Site 23, it is proposed that a similar containment design approach to solid waste disposal as has been developed for Site 1 be applied as well at Site 23. In fact, perusal of the possible natural geohydrologic environmental setting at Site 23 dictates a possibly greater need for assurance of complete containment of the solid wastes to minimize potentially adverse water quality impacts.

Both the major groundwater aquifers, i.e., the alluvial deposits of the Squirrel, Youngs, Tanner, and Little Youngs Creek valleys, and Anderson and Dietz coal seams of the Tongue River member and associated clinkers form a more or less continuous groundwater unit from the Wolf Mountains on the west to the Tongue River on the east. The movement of both the surface water and the groundwater is toward the Tongue River and external to the Crow Reservation. The potentiometric surface of the groundwater is also near ground surface levels.

Hence, the possibility could exist for a nearly continuous transport path for potential aqueous contaminants from synfuels plant process liquids and solid residues if the proposed containment liners are circumvented for any reason in the Shell mine-Site 23 area. Thus, additional precautions must be taken in the site selection, design, and construction of the aforementioned disposal areas—especially the solids waste facility—in the Shell mining area to make certain that (1) the waste disposal containment liners are capable of high, long-term integrity, and (2) continuous aqueous contaminant surface water or groundwater pathways are not possible in the waste disposal area in order to preclude any potentially adverse water quality impacts to the Tongue River drainage system.

Regardless of siting area, it is recommended that a thorough preoperational groundwater monitoring program be initiated at both the plant site in the vicinity of the proposed liquid waste storage area and at any solid waste disposal area.

Preliminary plant layout and design data indicate that approximately 1,250 acres will be required, thus disturbed, for Site 1. Approximately 960 acres will be encompassed within the plant boundaries and another 290 acres will be required for the access roads, railroads, and water pipeline. An additional 300 to 600 acres will also be required for a waste disposal site. Wildlife habitat within and adjacent to these proposed sites could be considered lost for the duration of the project. Terrestrial wildlife with limited mobility and small home range sizes will be most affected. Sharp-tailed grouse are known to be quite abundant within the general area and loss of habitat will directly impact populations.

Disturbances associated with the site preparation and construction process could impact pronghorn antelope and sharp-tailed grouse depending on the timing of construction activities. Uncontrolled access and activities could result in further disturbance, harassment, and poaching, thereby directly impacting wildlife populations particularly during winter months when populations such as pronghorn antelope and sharp-tailed grouse are concentrated.

Preliminary plant layout indicates that approximately 1,440 acres will be required for Site 23. Plant boundaries tentatively encompass approximately 750 acres. Approximately 60 miles of pipeline will be required to transport needed water supplies to the plant site. Access roads as proposed will cover approximately 27 mi. Total surface acres required for both the access roads and pipeline is about 690 acres. Therefore, a total of 1,440 acres of wildlife habitat could be considered lost for the duration of the project at Site 23. Since the solid waste would be disposed of in the Shell mining area, land disturbance would have occurred prior to any activities associated with the Crow synfuels project.

The proposed plant Site 23 area lies within a major pronghorn antelope winter range with plant boundaries overlapping or lying directly adjacent to critical-use areas.

Construction activities could seriously impact these animals depending on the timing of activities. Movements of antelope from the lower portions of the winter range to the upper northwest sections could be disrupted. Birthing activities of pronghorn antelope and mule deer could also be disrupted resulting in lowered reproductive success. Golden eagles and prairie falcons are also know to nest within close proximity to the plant site; therefore, any disturbance during nesting season could result in abandonment of the area.

Although activities associated with access road and pipeline construction will be temporary, impacts could be significant if these activities transpire during critical life-cycle periods for indigenous wildlife. Since access roads and pipelines will cross known mule deer, white-tailed deer, and elk ranges, uncontrolled access during construction activities could result in poaching and further harassments, particularly in more remote areas.

Some of the major concerns with ecological impacts of utility line corridors center on the management of the corridor. Herbicides have been used extensively in the past to maintain a clear right-of-way. This practice resulted in the loss of vegetation and, hence, carrying capacity. Thus, it is recommended that use of herbicides should be either avoided or strictly controlled. On the other hand, the areas relatively clear of overstory vegetation frequently have a good diversity of shrub vegetation and other understory vegetation. This, in turn, maintains a more diverse food web than the forest alone. Thus, the cleared right-of-way maintains an ecotone and introduces increased species diversity along the corridor if properly managed. Therefore, it is recommended that the ecology of the utility corridor be examined in greater detail after final site selection to reduce the potential impacts on the regional ecosystem. Since the length of the water pipeline corridor is considerably more extensive for Site 23, the potential for possible environmental impacts to both vegetation and wildlife are concomitantly greater. It must be emphasized, however, that over the long term, the most important mitigation measure with respect to utility corridors is to maintain the vegetation and, thus, the carrying capacity for wildlife.

It is further recommended that proper design of water intake structures on the Bighorn River be effected to reduce potential fish losses due to impingement.

In the Site 1 area, water quality degradation of Fly Creek and Two Leggins Creek could increase if measures are not taken to contain runoff and resultant sediment loads. Depending on the quantity of additional sediment resulting from construction activities, impacts to the Bighorn River fisheries could result. Similarly, in the vicinity of the Site 23 area, increased siltation of Youngs and Dry creeks and, consequently, the Tongue River could occur if measures are not taken to reduce or contain runoff from disturbed sites. The already low populations of brook trout in the upper reaches of Youngs and Dry creeks could be essentially eliminated if excessive siltation occurs. Likewise, the Owl Creek and Little Bighorn River fisheries could be impacted if excessive siltation occurs. Hence, strict procedural control during site preparation and construction activities is recommended to mitigate this potential impact.

The Site 1 location is bisected by a northeasterly-southwesterly trending fault approximately 5 miles in length. Since the geologic structure in this area is composed of the Niobrara and Carlile members of the Cody Shale Formation of the Late Cretaceous Period (65 to 100 million years ago) and the structural displacement is inferred to be less than 100 feet, the fault cannot be classified as capable. However, it is recommended that additional test drill data be developed to substantiate this premise if Site 1 becomes the eventual selected site for the Crow synfuels facility.

No major faults are known to occur in the Site 23 area, although a major northeast trending fault is inferred to cross the extreme southeastern corner of the siting area.

Since the extent of cultural resources for the majority of the Crow Reservation, including the proposed candidate plant sites, and areas of impacts are largely unknown, it becomes difficult to adequately assess the cultural or archaeological impacts for the proposed project. However, cultural resources are vulnerable to impacts from surface and subsurface disturbance and from intrusion into relatively inaccessible and remote areas.

Construction activities could totally destroy buried deposits if adequate and required archaeological clearances are not obtained. Increased human access to previously remote areas could enhance the potential for vandalism and theft at cultural sites. Valuable information important to the understanding of prehistoric and historic events could be lost or destroyed. Religious and sacred sites important to the Crow tradition could also be impacted. Compliance with all tribal, state, and federal rules, regulations, codes, orders, and proclamations will be required to adequately mitigate any adverse effects on this significant resource.

The question of jurisdiction over energy development on Indian reservations is concerned with whether, and under what circumstances, various governmental entities (tribal, federal, state, and county) have the legal authority to impose regulation. Therefore, a number of jurisdictional issues that may arise in the construction and operation of a coal gasification facility on the Crow Reservation have been identified.

This identification of issues and general principles is intended to promote planning of the facility in a manner that avoids jurisdictional conflicts, since there are ways in which the construction and operation of the facility can be structured to minimize the jurisdictional overlap. Such informed structuring should ultimately simplify the environmental review process by allowing clearer identification of those permits that are, in fact, necessary.

There appears to be no question that, in the vast majority of situations, federal environmental statutes can and will be applied to activities on Indian reservations. Several federal environmental statutes, such as the Federal Water Pollution Control Act, the Solid Waste Disposal Act, and the Surface Mining Control and Reclamation Act, are by their terms applicable to Indians or Indian lands. Others, such as the National Environmental Policy Act, make no specific mention of Indians or Indian lands. Perhaps the most that can be said about the current law of state jurisdiction over reservation activities is that the question of state authority is subject to a sliding-scale analysis; i.e., the more exclusively "Indian" the activities are, the less likely it is that a state may assert jurisdiction.

Two relatively clear principles emerge from the study analysis of jurisdictional issues. First, the federal government has pervasive authority to enforce federal statutes on reservations. Secondly, inherent tribal sovereignty should permit the application of tribal environmental statutes to Indians and non-Indians engaging in development activities anywhere on a reservation.

The applicability of state and county environmental regulations to activities on Indian reservations depends on a case-by-case analysis of facts, including the involvement of non-Indians in the activity, the location of the activity, the relationship between attempted state or county regulation and federal regulatory schemes, and the effect of the attempted regulation on the tribe's right of self-government. Because such facts about the coal gasification facility to be constructed on the Crow Reservation are not currently available, little basis exists for determining if state or county regulations might apply and, because informed planning, with active assistance of legal counsel and development of a tribal envrionmental review process might avoid jurisdictional conflicts, state and county regulations are not included in this feasibility study.

An evaluation of the existing regulatory framework for development of the Crow synfuels project reveals both potential problems and opportunities. Without proper planning, then confusion, delay, duplication of effort, and inefficiencies may result as is common in large projects. In recent years, however, agencies at all levels of government have taken steps to improve coordination and facilitate permitting. Coordination of permit requirements and full participation by the Crow Tribe and federal, state, and local agencies offer the greatest opportunity for improving and expediting the permit process.

The potential for environmental degradation through development of large-scale projects has resulted in the passage of a number of laws and regulations by tribal, federal, state, and local governments. Most of these regulations were developed independently, leading to conflicts, duplication, and overlap. Two or more levels of government may regulate the same aspects of the Crow synfuels project using different standards, procedures, timing, and information requirements.

Therefore, an appropriate timing sequence in relation to other development activity has been developed to establish an overall framework for scheduling major program elements associated with the environmental permitting process; i.e., prefeasibility study, feasibility analysis, decision to proceed with the project, environmental monitoring, NEPA process (preparation of EIS), environmental permitting process, and facility construction.

Several major federal environmental permits and approvals will likely be required prior to construction or operation of the proposed synfuels project. Based upon legal research and extensive discussion with government agency staff, it was concluded that six major permits probably will be required for the synfuels project as follows:

(1) PSD Permit;

(2) 404 Dredge and Fill Permit;

(3) NPDES Permit;

(4) Hazardous Waste Management Permits;

(5) Underground Injection Control Permit; and

(6) Coal Mining and Reclamation Permits.

The National Environmental Policy Act (NEPA), enacted in 1969, has been the most significant piece of legislation dealing with environmental matters. The most important feature of NEPA is that it requires all agencies of the federal government to prepare detailed "Environmental Impact Statements" (EIS) on major federal actions, programs, leases, projects, permits, etc., that significantly affect the quality of the human environment.

In most cases, it is concluded that major energy projects on Indian lands will require an EIS. The federal agency that is designated the lead agency responsible for the major action associated with the project is responsible for preparing the EIS consistent with its own regulations and those promulgated by the President's Council on Environmental Quality (CEQ). For Indian lands, this agency is usually the Bureau of Indian Affairs. With respect to major environmental permit programs the NPDES Permit, the 404 Dredge and Fill Permit, and the Coal Mining and Reclamation Permits are subject to both NEPA and EIS requirements. The PSD permit and the Hazardous Waste Management permits are exempt from NEPA and EIS requirements. The NPDES permit is subject to NEPA and EIS requirements if the permit is to be issued by EPA.

The federal NEPA requirements and preparation of an EIS can be a very time-consuming effort. Consistent with guidelines prepared by the CEQ, the requirements have been designed to assure full opportunity for review and participation by all interested parties. This open process exposes a project to a full range of public and political scrutiny as well as potential judicial attack. At a minimum, the time currently required to prepare an EIS is 18 months. However, large controversial projects could take significantly longer periods of time.

Tribal requirements are somewhat difficult to evaluate at present. The Crow Tribe has adopted an Environmental Health and Sanitation Ordinance which covers water supply, air quality, solid waste, and other health-related matters. However, this ordinance applies primarily to small-scale residential or community development. It is not yet designed to regulate environmental effects of large-scale industrial facilities. Additionally, some of the standards in the ordinance are inconsistent with current federal requirements.

The Crow Tribe has also adopted a reclamation code to govern surface mining of coal. Although the Crow Office of Reclamation is currently developing regulations and technical capabilities for administration, the code is not yet in force.

Large volumes of solid waste will result from the coal gasification facility, as previously discussed. It is anticipated that these wastes will be nonhazardous and, thus, not require a permit under Subtitle C of the Resource Conservation and Recovery Act. Even if certain wastes are considered hazardous under EPA regulations, only those wastes from the gasifiers would require a permit. The 1980 Amendments to RCRA defer fly ash, bottom ash, slag, and flue gas emissions control waste from fossil fuel steam generators from the Subtitle C program pending completion of an EPA study. Future regulation is a possibility.

Regulation of nonhazardous solid waste under Subtitle D is left totally with the states and presumably to tribal governments. Sections I, II, and IV of the Environmental Health and Sanitation Ordinance for the Crow Reservation relate to the permitting and licensing of business establishments and waste disposal facilities and may provide some authority and regulatory framework covering solid waste disposal from the synfuel facility. Clearly, however, this ordinance was not designed to address the type of solid waste problem associated with a coal gasification process.

In the absence of clear regulatory authority over nonhazardous solid waste disposal, the mitigation of possible environmental impacts can best be addressed through a complete analysis as a part of the Environmental Impact Statement Process under NEPA.

As previously discussed, the applicability of state environmental regulations to activities on Indian reservations depends on a site-specific and development-specific analysis of facts. The analysis should explore the involvement of non-Indians in the development, the location of the development, the relationship between the attempted state regulation and federal regulatory schemes, and the effect of the attempted regulation on the tribe's right of self-government. It is impossible at this stage of the project to predict with any accuracy which state regulations might apply. It must be emphasized, however, that the coal gasification project is a major project that can create significant environmental as well as social and economic impacts and will generate considerable interest and perhaps direct involvement of state and local governments. It is strongly recommended that the appropriate state and local officials be involved early in the environmental permitting process to ensure that possible off-reservation impacts are addressed.

A regulatory decision schedule requires the construction and combination of numerous elements. The procedures and deadlines set forth in statutes and regulations comprise the foundation. They are different for each permit, and in most cases, except for the PSD permit which has a statutory deadline of one year following the filing of a complete application, there is no limit on the timing for issuance. However, both the CEQ regulations governing the NEPA process and the EPA consolidated permit regulations, which includes NPDES and hazardous waste permits, provide for the establishment of project design schedules to encourage timely decision making. Additionally, agency policy and actual practice further delimit procedures and timing.

The regulatory decision schedule prepared for this study illustrates the close linkage of timing for the EIS and various permits. Because the EIS evaluates alternatives and may be a prerequisite to several federal decisions on the synfuels project, it should be prepared as early as possible. An early start is also recommended since the EIS process is a lengthy one (18 months or longer). Submission of applications for all required permits occurs, in the decision schedule, approximately eight months after the EIS process begins.

The EIS process normally should be started well before permit applications are submitted. This allows preliminary evaluation of impacts and alternatives prior to commitment to specific permit options. Furthermore, under the decision schedule, the applicant submits permits prior to agency review of the preliminary draft EIS, allowing agencies to evaluate the permit application and the EIS together. The schedule assumes that no formal public hearings on permit decision will be held until the final EIS has been prepared; therefore, the final EIS serves as an important tool in the decision-making process.

Preparation of a single EIS for the synfuels project, as shown in the decision schedule, is recommended as a prime area for consideration and increased efficiency in the review process. If a single EIS is used, the Bureau of Indian Affairs probably would assume primary responsibility for preparation. Other federal agencies would work with BIA on a cooperative basis, rather than prepare their own EIS.

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