40-3453

September 8 , 1995

MEMORANDUM TO: Joseph J. Holonich, Chief
HLUR/DWM/NMSS

See Report

FROM: Michael J. Bell, Chief /S/
ENGB/DWM/NMSS

SUBJECT: ATLAS TER INPUT - SECTIONS 2, 3, 4, AND 6

In accordance with Mike Fliegel's request, we have completed our review of the Reclamation Plan (RP) for the Atlas uranium mill in Moab, Utah. Based on our review, we conclude that additional information regarding rock gradations, landslides, radon barrier design, geotechnical engineering, and seismic design will be needed before the RP can be approved.

At Mr. Fliegel's request and in order to help expedite the process, we previously provided preliminary draft versions of our review results for the Technical Evaluation Report of Sections 3, 4 and 6; Subsections 2.3.5 and 2.4.3 of Section 2; and the discussions of Appendix A Compliance. These preliminary drafts had not undergone management review within ENGB. Unfortunately, this has led to substantial confusion as to which version of the text represents the approved version. This memorandum transmits the approved ENGB review of the Atlas RP. Section 2, not previously provided, is included in the attachment. Reference lists are also provided at the end of each section. Mr. Fliegel has indicated that the format for the references will be set by the NMSS editor, therefore, we have not specified a format for references in the various ENGB sections.

This review was performed by Phil Justus, Section 2; Buck Ibrahim, Subsections 2.3.5 and 2.4.3; Dan Rom, Section 3; Ted Johnson, Section 4; and Elaine Brummett, Section 6. If you have any questions, please contact the appropriate reviewer.

Attachment: As stated

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2.0 GEOLOGIC STABILITY

2.1 Introduction

This section of the draft TER documents the staff's review of geologic and seismologic information and analyses of Atlas Corporation's revised reclamation plan for its mill tailings site at Moab, Utah. 10 CFR Part 40 requires the tailings disposal area to be closed in accordance with a design which provides reasonable assurance of control of radiological hazards to be effective for 1000 years, to the extent reasonably achievable, and, in any case, for at least 200 years. Also, the tailings may not be located near a capable fault that could cause a maximum credible earthquake larger than that which the tailings could reasonably be expected to withstand [Appendix A, Criterion 4(e)].

NRC staff considers this standard (Appendix A) to mean that certain geologic and seismologic conditions [such as Criteria 4(e) and 6] must be met in order to have reasonable assurance that the long-term performance objectives will be met. Guidance with regard to these conditions is provided in Final Standard Review Plan (FSRP) for UMTRCA Title I sites which are applicable to Atlas and other Title II sites (NRC, 1993).

The staff's review of the geology and seismology is based upon the following sources of information and interpretations: Atlas Corporation's documents; interactions with Atlas Corporation and its consultants, including telephone conference calls, meetings and site visits; interactions (including exchange of documents, phone calls, field trips and office visits) with geologists, seismologists, hydrologists and rangers employed by the Utah Geological Survey (UGS), U.S. Geological Survey (USGS), University of Utah, Utah Division of Radiation Protection, U.S. National Park Service; proprietary reports of the Petroleum Science and Technology Institute, Edinburgh, Scotland; and independent sources, as cited.

2.2 Location

The Atlas site is located at the confluence of Moab Wash and the Colorado River, at the base of an escarpment of about 1100 feet of relief which borders an elongated, northwest-trending, topographic depression called Moab-Spanish Valley. Section 1.2 provides a more detailed description and map location of the site and vicinity in eastern Utah's Paradox Basin.

2.3 Geology

Atlas has presented information about the geology and seismology of its site from such sources as topographic maps and aerial photographs, soil and groundwater samples and literature searches. Subsurface geologic data derived from boreholes and logs of cuttings were presented as recommended in Final Standard Review Plan, Section 1.3.2 (NRC, 1993). However, Atlas has not documented an adequate understanding of the alluvium and bedrock beneath the tailings sufficient to demonstrate a design that ensures that potential future disruptions of the radon and erosion protection barriers will meet NRC requirements (Appendix A, Criterion 6). The staff has independently compiled

the following descriptions of the site geologic setting emphasizing those features, conditions, processes and events that represent potential geologic hazards or conditions that could adversely affect site stability during the next 200 to 1000 years.

2.3.1 Physiographic Setting

The site is located in the Moab-Spanish Valley, one of about eight prominent topographic depressions in the Paradox Basin. General technical descriptions, which include maps and cross sections of the Colorado Plateau physiographic province and its subprovince, the Paradox Basin in which the Atlas site lies, may be found in the following references: Cater (1970); Doelling (1985, 1988) and Hunt (1969, 1974).

2.3.1.1 Colorado Plateau Physiographic Province

The Atlas site lies within a geologically distinct sedimentary rock basin - the Paradox Basin - that is part of the Colorado Plateau physiographic province (CPPP). The CPPP is characterized by extensive plateaus bordered by receding escarpments, canyons, altitudes generally exceeding 5000 feet, semi-arid climate (except for variations caused by local altitude), and angular topography due to the combination of gently dipping strata of contrasting resistance to erosion and penetrative near-vertical fracture sets.

Much of the physiography of the CPPP can be related to subsurface geological structures. Examples of physiographic features that are related to subsurface and near-surface structures are salt anticlines and salt depressions like the Moab anticline and Valley, upwarps like the Umcompahgre Plateau, fault valleys like the Lisbon Valley, igneous domal uplifts like the La Sal Mountains, the grabens of Canyonlands National Park (N.P.), and the fins and arches of Arches N.P.

The incised landscape of the CPPP results principally from erosion dominated by stream transport. The depositional effects of transport by gravity (such as talus and landslides) and by wind (such as sand dunes) are also widespread. However, the spectacular canyons and escarpments (such as the Spider Mesa escarpment adjacent to the site) are evidence of stream migration and incision in response to plateau uplift often with obvious structural controls.

The Colorado River and its tributaries dominate the drainage history of the plateau and the Paradox Basin. The geomorphic evolution of the Colorado River is discussed briefly in the Section 2.3.4 on geomorphic setting.

2.3.1.2 Paradox Basin

The Atlas site lies within the thickest stratigraphic section and most structurally deformed zone of a northwest-trending wedge-shaped sequence of sedimentary rocks called the Paradox Basin. Paradox Basin sediments filled an asymmetric structural depression a few miles deep. The sedimentary rock wedge is thinner and less deformed toward the southwest, beyond Monticello, San Juan County, Utah, and in the vicinity of Cortez, Montezuma County, Colorado (Cater, 1970). The thickest part of the basin was subjected to a variety of

geologic processes, including cyclical evaporite deposition in the Pennsylvanian Period, faulting, salt diapirism, folding, igneous intrusion, jointing, uplift, subsidence, erosion, and seismicity.

The topography in the northeastern part of the Paradox Basin, in which Moab is located, is dominated by features associated with northwest-southeast-trending folds, faults and steep-walled valleys elongated parallel to the structures. Prominent valleys are underlain by salt-cored anticlines on block-faulted Precambrian metamorphic basement rock. Salt structures apparently intruded, faulted and upwarped the sedimentary cover rocks by diapirism. Subsequent dissolution and creep of the near-surface salt beds led to the subsidence of the cover rocks. Cover rocks subsided by slipping on normal faults and downwarping, among other processes (Cater, 1970; Doelling, 1985, 1988).

The escarpments which border the elongated valleys formed along fault scarps that have retreated to their present position by erosional processes. The Poison Spider Mesa escarpment adjacent to the Atlas site is such a feature. Moab-Spanish Valley is one of the salt-cored anticlines that breached the surface. However, as the Moab salt-cored anticline plunges to the northwest under the Atlas site, the surface expression of breaching becomes progressively more subdued and is generally absent northwest of the Bartlett Wash area.

2.3.2 Stratigraphic Setting

The thick part of the wedge of the Paradox Basin sedimentary rocks (e.g., the Moab area) has had a long history of deposition and erosion in marine and continental environments periodically punctuated by tectonic, geomorphic and climatic processes and events. The regional stratigraphy is briefly described to provide background to discussions of processes that are deemed likely to continue to operate over the next 1000 years. UGS defers to Molenaar's (1975) lexicon of stratigraphic names for appropriate use in the Paradox Basin. The staff considers the stratigraphic nomenclature and correlations in Doelling, et al. (in press) appropriate for this licensing action. Atlas has not yet characterized the Quaternary alluvium, the Paleozoic and, if present, the Mesozoic rocks, or the basement rocks beneath the site to the extent necessary to support conclusions of subsurface and bedrock stability. The staff has compiled the following descriptions from the literature and from discussions with UGS geologists.

2.3.2.1 Stratigraphy of the Moab Area, Utah

The Moab area was a depocenter during most of the Paleozoic and Mesozoic Eras. The Paleozoic rock sequence is represented by Permian age rocks of the Cutler Formation, Pennsylvanian rocks of the Honaker Trail Formation and Paradox Formation, and Mississippian and older rocks known to occur in the subsurface (Doelling, et al., in press, Description and Correlation of Map and Bedrock Units). A stratigraphic column for Moab 7.5' Quadrangle with unit descriptions was developed by UGS (in press). In the Early Pennsylvanian, the basin subsided relative to the tectonic uplifting of the Uncompahgre Mountains. The basin was nearly filled with cyclical deposits of marine evaporite minerals by the end of the Late Pennsylvanian Epoch. Deposits of

potash minerals and other evaporite mineral resources occur in these rocks.

Late Pennsylvanian to Late Cretaceous continental (non-marine) deposits are represented in the Moab area. Varying thicknesses of Late Pennsylvanian to latest Triassic (possibly into the Cretaceous) units have been attributed to syndepositional diapirism of the Paradox Formation.

Marine conditions existed in the basin throughout the Late Cretaceous Epoch during which clays, silts, and thin layers of sand now referred to as the Mancos Shale were deposited. The Mancos is exposed by the Moab airport and along Interstate 70 to near Cisco. At the end of the Cretaceous Period, uplift occurred over what is now termed the CPPP and the "Mancos sea" retreated.

There is little rock record for the interval from 67 million to about 5 million years ago in the Paradox Basin. Magma of trachytic and rhyolitic composition intruded the area that is now the La Sal Mountains about 25 million years ago. Regional uplift of the CPPP began about 10 million years ago and could partially explain the dearth of Tertiary sedimentary deposits.

The Paradox Basin salt valleys, such as Moab-Spanish Valley, which formed by collapse of cover rocks above salt-cored anticlines, have conspicuous deposits of sediments and caprock that are predominantly Quaternary in age. These deposits suggest that the Moab Valley has been a local depocenter and site of dissolutioning during the Quaternary.

2.3.2.2 Quaternary Stratigraphy

The Atlas site is underlain by alluvium that apparently is greater than 400 feet thick, as suggested from a drillhole on site. The site is at the confluence of the Colorado River and Moab Wash. Therefore, alluvium from both fluvial systems might be present beneath the site. The local base level is the Colorado River bed and appears to be controlled by the elevation of the bedrock channel at The Portal. Thus, the accumulation of alluvium from either Moab Wash or the Colorado River at the site to depths below the elevation of The Portal suggests that the site and the vicinity of Moab Marsh could have been subjected to local subsidence on the order of hundreds of feet. The general maximum thickness of alluvium in Moab Valley is about 500 feet, shown schematically on UGS cross sections (Doelling, et al., in press).

To date the stratigraphic heterogeneities and geometry of the alluvial wedge beneath the site have not been defined by Atlas for purposes of assessing site response to future geologic events, such as seismicity. A fluvial history of the alluvium beneath the site has not been described sufficiently to be applied to estimate the potential future course of the Colorado River or Moab Wash across the site, to estimate subsidence rate, or to estimate a sedimentation rate for the site.

Fluvial terrace deposits at various levels along the Colorado River and Moab-Spanish Valley represent ancestral higher base levels of the Colorado River and its tributaries. Tilting, angular unconformities and progressively younger ages of Pack Creek terraces toward the Colorado River are evidence of

Quaternary subsidence of the Moab salt-cored anticline (Harden, et al., 1985). It has been suggested that the marshes across the Colorado River from the site represent a zone of contemporary subsidence (Harden, et al., 1985). Atlas plans to investigate latest Quaternary rates of stream incision of Courthouse Wash in order to constrain maximum subsidence rates for Moab Valley northwest of the Colorado River.

Eolian sand deposits occur as dunes and discontinuous sheets in the Arches N.P. area near the site (Huntoon, et al., 1982). They are derived from the numerous sandstones, especially the Jurassic Entrada Sandstone (Doelling, et al., in press, Description of Map Units). In the Moab area, sand is transported from the west and accumulates on the northeast-facing slopes and their base (Doelling, 1988). The slopes of Poison Spider Mesa are a prime zone of accumulation. Such deposits occur near the site and are active.

Landslide deposits, coherent rock masses that slip on shears that develop on oversteepened cliffs or on previously developed faults or joints, have been mapped in Moab Valley, including the cliff adjacent to the site (Huntoon, et al., 1982; Doelling, et al., in press). They are often associated with the Morrison Formation (Doelling, 1988).

Talus deposits are accumulations of rock block, and debris falls on and at the base of steep slopes. Talus has been mapped adjacent to the site. Atlas has assessed the effects of rock falls and talus encroachment into the drainage system on the western side of the pile (Section 4.5.1.3.2).

Two volcanic events that might have affected the site have been preserved in Quaternary basins in Arches N.P. A volcano erupted near Bishop, CA, about 740,000 years ago. Ash from the eruption wafted to the area and scattered deposits are preserved. At about 620,000 years ago, ash from an eruption in the Yellowstone area was transported into Arches, and as much as 13 feet of compacted ash have been preserved (Oviatt, 1988).

2.3.3 Structural Setting

Complex geologic structures have been mapped in the site vicinity and beneath the site. The location and activity, if any, of the Moab fault system has been particularly controversial because of the absence of conclusive evidence for its existence beneath the site. Atlas appears to agree with the UGS interpretation (Doelling, et al., in press) that a splay of the Moab fault system underlies the site but appears to disagree with interpretations which suggest that the main Moab fault underlies the site (e.g., Baars and Doelling, 1987; Doelling, 1985, 1988; Huntoon, et al., 1982). To date Atlas has performed a literature review of the Moab fault system. Atlas has agreed to investigate the Moab fault to gather primary data such as those described in FSRP Sections 1.3.2, 1.3.3 and 1.3.5 (NRC, 1993). Also, Atlas is conducting investigations to assess the potential for local subsidence due to salt dissolutioning or salt flow to occur in the next 1000 years. The staff has reviewed the literature and has developed the following summaries of relevant structural features, conditions, processes, and events which provide a basis for discussions of potential future structural events.

2.3.3.1 Structural Features

The Atlas site area contains evidence of previous seismotectonic, salt tectonic (gravitational tectonic), and igneous activity. On a regional seismotectonic scale, displacement along predominantly northwest-trending faults in the basement rocks created the Paradox sedimentary basin during a Late Paleozoic period of tectonism which thrust the Uncompahgre Plateau, Precambrian basement, 20,000 feet vertically and 30,000 feet horizontally (Ross, in press). There is also evidence for Late Mesozoic-Early Tertiary regional tectonism. Regional uplift of the Colorado Plateau commencing in the Miocene and continuing at present is also in evidence (Cater, 1970).

Evidence of normal faulting on northwest- to north northwest-trending pre-existing faults and fractures and strike-slip faulting on northwest- and northeast-trending shallow faults and fractures indicate that the current state of stress in the Colorado Plateau is generally northeast-southwest extension (Wong and Humphrey, 1989). Such conditions suggest that the Moab fault system, faults and fractures parallel to Moab Valley, and basement faults of northwesterly and northeasterly orientation beneath the site area, are favorably oriented for displacement and coseismic activity. However, there is great uncertainty about the likelihood of such events.

Tectonism is generally considered to have initiated the salt-wall diapirism of the Late Paleozoic through Jurassic which led to the formation of salt-cored anticlines with long northwest-trending master faults, such as the Moab fault. Some of the diapirs breached, or nearly breached, cover rocks. Other diapirs, like the Lisbon Valley salt-cored anticline, have a master fault(s) that penetrated cover rocks, e.g., the Lisbon Valley fault, but have not sufficiently deformed the cover rocks and dissolved or flowed laterally to the extent necessary to initiate collapse of the cover rocks (Cater, 1970).

Mid-Tertiary (about 25 million years old) igneous intrusions which comprise the La Sal Mountains are considered to be structurally controlled by northwest-trending and northeast-trending faults in the Precambrian basement (Ross, in press). In particular, the southern intrusive complex intruded the northwest basement fault that is projected to underlie Moab-Spanish Valley. Northeast-trending basement faults are considered to segment the basement into blocks. The Moab-Spanish Valley basement fault (NW) and the Castle Valley-Paradox Valley basement fault (NW) are possibly connected by a northeast-trending basement fault, south of Wilson Mesa (Friedman, et al., 1994; Ross, in press). The trace of these faults separates deeper basement (7,000-14,000 feet below sea level) of the northeast portion of the Paradox Basin, from shallower basement, to the south and west. The intrusives occur in and near the fault-controlled, steep, basement-elevation-gradient.

A recent review of the geophysical and geological evidence for northeast-trending structures in the basement (Friedman, et al., 1994), suggested that such features are faults thousands of feet beneath the Colorado River and beneath the middle La Sal Mountains, among other places. In addition, some authors have suggested that basement faults were involved in the alignment of the Colorado River and the La Sal Mountains intrusions (e.g., Friedman, et al., 1994; Ross, in press; Hite, 1975). Further, it has been suggested that

the Colorado River seismic zone might be a manifestation of movement of a basement fault segment beneath the river (Wong and Humphrey, 1989). Two northeasterly faults transect the Moab fault, the Roberts Rift (Hite, 1975) and the Kane Spring graben system (Friedman, et al., 1994). The Roberts Rift is brecciated and mineralized and considered to be deep-seated, though its displacement is small. The Kane Spring graben is at the southeastern terminus of the Moab fault. The Lisbon Valley fault also terminates at the graben. Several faults parallel to the Lisbon Valley fault, near Lisbon, may have last moved in the Holocene (Woodward-Clyde, 1982b). Evidence suggests that a fault in the Kane Spring graben system moved in the Pleistocene (Friedman, et al., 1994). Should the Kane Spring graben or the Lisbon Valley fault system have a structural connection to the Moab fault system, then that would constitute evidence for presuming that the Moab fault is a capable fault.

The Paradox Basin structures have been considered to be compatible with a wrench tectonic system, and it has been suggested that part of the Basin is a pull-apart structure (Stevinson and Baars, 1986).

2.3.3.2 Salt Tectonics - Diapirism and Subsidence

Atlas has postulated that lower rates of subsidence related to salt dissolution are occurring now than have occurred in the past (Woodward-Clyde, 1994, p. 10). The only basis provided to support this statement is that "...[subsidence or dissolution] rates have probably slowed down since the time of Pinedale glaciation (roughly 15,000 to 25,000 years ago) due to a drier climate" (ibid., p. 10). Also, Atlas has asserted that "...there is no evidence for late Quaternary subsidence north of the Colorado River in the vicinity of the tailings pile" (ibid., p. 10). However, more than 400 feet of alluvium, some of it probably late Quaternary, observed by Atlas in boreholes beneath the tailings, suggests that subsidence may have occurred enabling sediments to accumulate there.

The thick alluvium beneath the pile (Dames and Moore, 1987), the suggestion by Woodward-Clyde (1982, vol. 1, p. 3-16), and Harden, et al. (1986) that Moab Marsh might represent a broad subsidence basin, the beheading of Little Valley (Allison, 1994), the salt tectonic model of Baars and Doelling (1987) and Doelling (1988) that includes salt dissolution and landsliding beneath the tailings, and other information [such as the "buried scarp" (Section 2.4.1.2)] have not yet been considered by Atlas in its evaluation of the subsidence potential for the site.

Moreover, numerous breccia pipe collapse features attributed to a dissolutioning-stoping mechanism have been identified in the Spanish Valley (Suguira and Kitcho, 1981; Weir, et al. 1961). Such a breccia has been mapped about 5 miles from the site at Arches N.P. entrance (Doelling, et al., in press). Also, sinkhole-like collapse features have been reported in the Salt Valley-Cache Valley and Castle Valley areas (Doelling, 1988; Mulvey, 1992). These may be analogs for Moab Valley. Although some of these features may be of Tertiary age and, as a result, of no consequence to the site, their occurrence, or potential future occurrence, beneath or near the site, has not been investigated or analyzed by Atlas.

The UGS considers that subsidence in the vicinity of the Atlas site is continuing but has no site-specific data on the rate. Based on observations of relatively rapid and episodic types of collapse features (e.g., sinkholes, breccia pipes, landslides, and faults), and of relatively slow types of subsidence features (e.g., folds, syndepositional thickening, unconformities and faults), the UGS considers that a range of rates of future subsidence is possible in the site vicinity (Allison, 1994).

Several estimates of long-term average rates of subsidence, incision of the Colorado River, and denudation for drainage domains in the Colorado Plateau, have been made. They all fall in the range 0.3 to 3.1 feet per 1000 years (Allison, 1994; Friedman, et al., 1994; Woodward-Clyde, 1982a, p. 3-20 to 3-21). Such rates, determined from outside the Moab area, will be considered in deliberations of long-term stability of Moab Valley. These average rate estimates say little about the potential for rapid subsidence-collapse hazards. It remains for Atlas to fully evaluate and estimate the subsidence hazard from all reasonable sources.

2.3.3.3 Moab Fault System

The location and nature of the Moab fault, especially near the Atlas site, has been subject to several interpretations. For example, McKnight (1940) mapped the fault along the base of the northeastern valley wall, not underlying the present Atlas site. Williams (1964) mapped the fault along the lower slope of the Poison Spider Mesa escarpment, near the current location of the West Branch fault, but not underlying the site. Huntoon, et al. (1982) mapped one splay of the Moab fault trending toward but terminating just beyond the site boundary and another fault skirting the pile along the base of Poison Spider Mesa escarpment. Doelling (1985; Allison, 1994) mapped the main Moab fault trace (queried) under the pile and the West Branch of the Moab fault dipping under the pile (indicating the possibility of two faults underlying the site). Doelling, et al. (in press) have mapped three faults within the site boundary: (1) the main Moab (queried) is considered to have overlain the site (it has been removed by erosion); (2) the West Branch fault which dips under the site; and (3) an unnamed arcuate fault which intersects the projection of the other two faults (this is the "buried fault" introduced earlier that is not considered part of the Moab fault system).

Atlas has not completed its response to the staff's request for an assessment of whether or not the Moab fault is a capable fault (Blubaugh, 1994; Holonich, 1994). In particular, specific knowledge of the fault's characteristics and history are needed to address the criteria for the identification of a capable fault. Atlas asserted that because the Moab does not appear to offset Quaternary sediments, such as at Bartlett Wash, the fault is not a capable fault. That conclusion was not adequately supported by field and lab analyses (Holonich, 1994). Furthermore, the fault could, by definition, be considered a capable fault if macroseismicity is associated with it, or if it is structurally related to a feature that is capable. In June 1995, the UGS issued a preliminary geologic map of the Moab area which suggests that the Moab fault is rooted in the Moab salt-cored anticline and is not structurally connected to the basement. Such a fault would not meet the definition of a capable fault (*Code of Federal Regulations*, 10 CFR Part 100, Appendix A),

however, it could still represent a hazard that would need to be assessed because of its proximity to the site. Atlas is implementing a plan to fully address the capable fault issue.

2.3.3.4 Joint Patterns and Rock Fracturing

Recent studies of joint sets that are exposed in the rim synclines and plateaus around Moab Valley and Arches N.P. show that some sets are related to the reactivation of basement structures. However, regional joint sets have produced the dominant fracture fabric of the exposed rocks. These sets more definitively reflect the paleostress fields that produced them (Cruikshank and Aydin, 1995). It is clear to some that the regional fracture sets are discreet spatially and temporally and were not produced by propagation upward from the basement (Cruikshank and Aydin, 1995; Verbeek and Grout, in press). Concepts of rock fractures are relevant to analyses of groundwater flow, mass wasting of slopes, and identification of stress fields that may be favorable for rejuvenation of joints or development of faults. The reports mentioned above form a sufficient basis for consideration of the effects of joints on rock mass characteristics and groundwater flow.

2.3.3.5 Volcanism

Volcanic ash from volcanoes in the Western United States fell within 15 miles of the site, in Salt Valley (Arches N.P.), from at least two major volcanic eruptions about 740,000 (Bishop Tuff) and 620,000 (Lava Creek B) years ago (Oviatt, 1988). Also, ash beds thought to be correlative to those in Salt Valley have been described from Fisher Valley (Coleman, 1983). The volcanic sources of these Utah ash deposits are active today: Long Valley caldera, CA (Bishop); and Yellowstone N.P., ID/WY (Lava Creek B).

2.3.4 Geomorphic Setting

2.3.4.1 Topography and Geomorphic Features

The Moab, Utah 15' topographic quadrangle is dominated by the Colorado River (NE to SW), Moab-Spanish Valley (NW to SE), and plateaus dissected by washes. The Atlas tailings pile is nestled in the northwest terminus of Moab Valley between the Colorado River and the escarpments that define the valley. It sits at the confluence of Moab Wash and the Colorado River and is on the floodplain of the river. The Colorado River is rock-defended, has no appreciable flood plain, just prior to entering and leaving Moab Valley. Across the river from the pile lies the Moab Marsh or slough, the largest marsh on the river. The Moab Valley's southeastern end is about 15 miles from the Colorado River at Kane Springs. The valley is about 1.5 miles wide where the Colorado River transects it, and the relief at the pile is about 1100 feet. The valley walls are fault line scarps. Linear (actually planar) topographic features in the rim plateaus north and south of Moab intersect the valley walls. The linears on the plateau south of town trend E-W and represent an eroded joint set. Within a mile north of town, NW-trending linears intersect the valley at the river. These linears are faults. Trending northwest from the site through Moab Canyon is Moab Wash that heads at Little Canyon and appears to have captured Little Canyon Wash. Moab Canyon

marks the Moab fault trace. The Moab fault trace runs northwest along the foot of the increasingly subdued scarp to near Courthouse Rock and beyond. Courthouse Wash, which drains much of Arches N.P., joins the Colorado near and upstream from the Atlas mill. Terraces occur near the mouth of Courthouse Wash and at various locations along Mill Creek and Pack Creek southeast of town in Spanish Valley.

2.3.4.2 Colorado River and Its Tributaries

The Colorado River channel in its Moab Valley reach is the local base level of Moab-Spanish Valley because the Colorado is rock-defended at The Portal. Therefore, the tributaries to the Colorado (such as Pack and Mill Creeks, flowing northwest, and Courthouse and Moab Washes, flowing southeast) have been, and are likely to remain, in confluence with the Colorado at the elevation of The Portal.

UGS has provided its perspective on the issue of migration of the Colorado River to the northwest, where the site is located (Allison, 1994). The following is a summary of the UGS discussion.

UGS has mapped the modern flood plain of the Colorado River in the Moab 7.5' quadrangle (Doelling et al., in press). Stream terraces that mark the former course and elevation of the Colorado River and its tributaries are also mapped. Colorado River terrace gravels are present on the east side of Courthouse Wash about 40 feet above the modern river channel. Atlas plans to conduct stream profiling and soil studies in this reach to gain an understanding of incision rates or subsidence rates.

Gravels are present west of the tailings about 90 feet above the modern river channel. If these are remnants of a former position of the Colorado River, then the Colorado River probably occupied the Atlas site (in Pleistocene time).

UGS considers it possible that the tailings may be affected by channel migration of the Colorado River and erosion within the next 1000 years. The UGS also considers the current river bank deposits from Moab and Courthouse Washes to be sufficiently heterogeneous in grain size (even with cobbles present) and laterally discontinuous to not be a reliable deterrent to river-bank erosion.

Vegetation is also a factor when considering the stability of the river bank. Because most of the modern flood plain was inundated in the early 1980s, the UGS considers it likely that upper flood plain deposits are Holocene. There is no conclusive data available which would indicate that subsidence caused by dissolution of salt affected the migration of the Colorado River in Moab Valley.

2.3.4.3 Geomorphic Processes

Running water, gravitational, and eolian processes are active in the vicinity of the site and have had an effect on impoundment design. With regard to running water, discharge from Moab Wash has been controlled by diversion

channels, and a channel of the Colorado River was partially diverted by emplacement of a rock sill. Additional considerations of running water are evaluated in Section 5.2.

With regard to gravitational processes, the approximately 1100 feet of relief on Poison Spider Mesa escarpment adjacent to the site and near-vertical joints sets and faults, such as the West Branch of the Moab fault system, have promoted mass wasting of the scarp. Rates of scarp retreat estimated for rock types like those holding up Poison Spider Mesa (mainly Triassic and Jurassic sedimentary rocks), based upon long-term erosion of a variety of rock faces, is about .8 feet to 1.8 feet per 1000 years (Woodward-Clyde, 1982a, p. 3-21). Rock falls have been considered by Atlas and are discussed in Section 4.5.1.3.2. The landslide potential is being addressed by Atlas. Salt diapirism is a gravitational process but is considered under the heading of structural geology.

Wind, aridity, the availability of sand-size particles and nooks, crannies, and rock bastions have combined to promote the deposition of sand dunes, sand ramps and sand sheets in the Moab area (Doelling, et al., in press). Observations indicate that the eolian process continues to be active in the area. Sand may migrate onto the tailings or into drainage channels. Atlas is addressing this issue.

2.3.5 Seismicity

The licensee provided information on the seismicity of the site and environs in the Safety Analysis Report (SAR) in 1975. The seismic design of the reclamation plan approved by NRC in 1982 relied on information contained in the SAR. However, since issuance of the SAR, considerable geological and seismological data have been obtained in and around the Atlas mill tailings site. As a result, the staff concluded that it was necessary to reassess the seismicity of the Atlas site.

In its review, the staff has evaluated tectonic provinces and the association between earthquake activity and faulting to determine the vibratory ground motion corresponding to the maximum credible earthquake as required in Criterion 4 of Appendix A to 10 CFR Part 40. In the SAR, the licensee had indicated that there are two potential sources that could generate the maximum credible earthquake at the site. The first is a random earthquake in the northern Colorado Plateau of Intensity V (magnitude 4.0) generating an acceleration of about 0.02g at the site. The other source would be near the Wasatch Front which could generate a maximum magnitude earthquake of 7.4 that would produce an acceleration of 0.02g at the site. The licensee further stated that introducing a margin of conservatism, to account for amplification and a possible locally larger earthquake, the design acceleration will be taken as 0.05g.

In addressing the potential for capable faults to exist in the site area, the licensee indicated that a postulated northeast-trending feature coinciding with the trend of the Colorado River, if it exists, is probably of Precambrian or Paleozoic age. Also, the SAR states on page 2.4-30 that "There has been no seismic activity associated with this trend." This statement is not supported

by recent observations (Wong and Humphrey, 1989) which indicates that a swarm of seismic activity north of the confluence of the Colorado River and the Green River is associated with this trend.

In response to requests for additional information regarding several topics, and in particular about the capability of the Moab fault and the maximum credible earthquake for the Colorado Plateau, the licensee provided additional seismic information in its May 31, 1994, submittal. In that response the licensee indicated that the impoundment could withstand an earthquake that produced a horizontal acceleration of 0.25g at the site (see Section 3.3 for further discussion of the seismic stability of the impoundment). However, the licensee's response did not adequately address the seismicity in the vicinity of the site. The licensee has proposed a work plan to obtain additional data to address the staff comments on issues related to geology, seismology, and subsidence. The results from these additional investigations have not yet been submitted to NRC.

Geological, seismological, and geophysical information which has been developed since issuance of the SAR includes the following:

1. Geological mapping and reports from the Utah Geological Survey;

2. Several trenches on suspected faults excavated for the licensee by its consultant, Woodward & Clyde Federal Services; and

3. Geophysical surveys at the site.

In addition, the NRC staff has engaged in consultations and discussions with University of Utah faculty.

The analyses of the data have resulted in an increased understanding of the surface and subsurface conditions of the site and its vicinity. The new data dictated that the staff reevaluate the maximum credible earthquake that could be generated in the area and the resulting ground acceleration at the site.

The Atlas site is located at approximately 38^0 36' 13" N and 109^0 35' 25" W in Utah. Utah is subdivided into three major physiographic and tectonic provinces: 1) the Basin and Range; 2) Middle Rocky Mountains; and 3) the Colorado Plateau (Wong and Humphrey, 1989). The Atlas site is located in the Paradox Basin in the interior of the Colorado Plateau. The plateau is generally considered to be relatively stable. The historic record of seismicity in the plateau is very short, and adequate seismic coverage of the area did not occur until 1970. In 1970, the University of Utah, Los Alamos National Laboratory, and the United States Geological Survey installed a regional seismic network which improved the detection of earthquakes to those above magnitude 2.0. The boundaries of the Colorado Plateau are in part adjacent to major zones of recurrent seismic activity. For example, along the western margin of the plateau, there is a significant source of seismicity along the Intermountain Belt (IMB). This belt exhibits a moderate to high level of seismicity of magnitude up to 7.5. This belt is 75-100 km wide and forms a tectonic transition zone between Colorado Plateau and Basin and Range Tectonic Provinces. The IMB boundary is about 200 km from the Atlas site, so

the contribution of a large seismic event in the IMB at the site will be negligible.

The Atlas site is located in an area characterized by infrequent, low-level, small magnitude earthquakes. Prior to 1961, the locations of earthquakes were based on the "felt" area. From 1853 to July 1979, 22 seismic events with magnitude greater than 3.0 occurred within the Paradox Basin. From July 29, 1979, to November 1980, a network of stations was installed around the Colorado River south of Moab.

The objective of the network is to identify active earthquake sources within the Paradox Basin. During this period, about 500 seismic events with magnitudes greater than 1.0 were recorded in the Paradox Basin. On July 29, 1979, a micro-earthquake swarm was located along the Colorado River about 10 km northeast of its confluence with the Green River. During the 15-month period, about 200 seismic events were recorded along 35 km of the Colorado River between the confluence and Moab. The earthquakes show a north-northeast linear trend along the Colorado River which terminates at Moab. The depth of these earthquakes range from shallow to 50 km. Ninety five percent of the micro-earthquakes occurring in the Paradox Basin are confined to the Colorado Plateau.

From July 1979 to June 1987, about 1100 earthquakes up to magnitude 3.3 were recorded within a 200 km radius of Moab. Examination of temporal behavior of the micro-earthquake showed an apparent increased level of activity during period of brine extraction.

Based on aeromagnetic data, the loop part of the Colorado River appears to be underlain by a fault or fault zone within Precambrian basement that has previous left-lateral slip displacement (Case and Joesting, 1972). Hite (1975) proposed that several northeast-trending physiographic features in the region, including the Colorado River below Moab, may be structurally controlled by basement shear zones or strike slip faults. Fault plane solutions from some of these earthquakes north of the confluence of the Colorado and Green Rivers show strike-slip movements. Also, it was suggested that the tectonic stresses in the Colorado Plateau appear to be at critical levels and could provide sufficient strain energy accumulation necessary to generate earthquakes associated with zones of weakness parallel to the Colorado River. Wong, et al. (1983) concluded, based on their observations of the seismic activity in the Paradox Basin, that the tectonic state of stress in the area is such that some structural features may be near failure.

The largest earthquake recorded in the Colorado Plateau is a magnitude 6.5 event (McGuire, et al., 1982). The seismic events in the Plateau appear to be the result of activation of pre-existing faults favorably oriented to the stress field. Earthquakes in the Plateau occur in the upper 20 km of the crust.

2.3.6 Natural Resources

There are natural resources on and around the Atlas site. Also, underground storage of liquid natural gas in cavities in salt has occurred in Moab.

Groundwater is a resource in the area (Section __). There is an oil field about 12 miles away, and a solution potash mining operation about 8 miles away. Production of those resources is associated with salt strata or salt structures similar to those associated with the salt-cored anticline which underlies Moab Valley and the site. Atlas has addressed the matter of past, present, and potential future potash mining and extraction of oil and gas beneath the site for the purpose of assessing future tailings stability. The following is a summary of the natural resources setting derived from Atlas' reports (Norman, 1995a, 1995b), among others.

2.3.6.1 Potash

Salt layers 5 and 9 in the Paradox Formation are the main targets for potash minerals. These layers have been sought in borehole data (cuttings, geophysical, and lithologic logs) and in seismic reflection surveys. One of the test holes investigated was the Embar-Big Six, about 400 feet south of the Atlas site. Norman (1995a) reports that the salt layers were very thin, and concluded that "...there is no possibility for potash or other valuable salt minerals to be present under the current Atlas Tailing pile" (ibid., p. 35; it should be noted that the opposite conclusion was reached for the Bartlett Wash alternate site). It is not clear from Norman's report (ibid., p. 40-41) how the 500-feet-thick salt layers with interbedded clastics (his thin potash-poor salt section) under the site relate to the approximately 7000-feet-thick Paradox Formation under the site (Doelling, et al., in press, cross section B-B').

No surface subsidence is observed at the nearby Cane Creek potash mine where solution mining is in current use (Morton, 1995; Allison, 1994). However, subsurface collapses in this mine have generated earthquakes of magnitude up to 3.1 (Wong and Humphrey, 1989).

2.3.6.2 Oil and Gas

The Paradox Basin has been producing oil for about 70 years. The main targets have been the Mississippian (Leadville) limestone and the Cane Creek shale. Both occur in the Moab area (Morgan, et al., 1991; Morgan, 1992). Norman (1995b) reports thinned upper salt layers, absence of lower salt layers which contains oil shale targets, absence of Mississippian rock targets and only traces of oil, gas or brine in the Embar well near the site and concluded that "There is no possible commercial oil and gas potential at, or in the near vicinity of Atlas Corporation's Moab tailings pile" (ibid., p. 4; note that the opposite conclusion was suggested for the Bartlett Wash alternate site).

Oil and gas prospecting in the Moab area appears likely to continue. New techniques, such as horizontal drilling, have increased success in recovering oil from shale in the area. However, improved casing and plugging technology will lessen solutioning and subsidence around boreholes and better contain the high fluid pressures in the producing units. Surface subsidence over oil wells in Grand County has not been noted (Allison, 1994, p. 14).

2.3.6.3 Underground Storage Space

Underground storage of liquid natural gas was attempted in the salt-cored anticline beneath the town of Moab (Woodward-Clyde, 1982a, p. 8-5). The liquid was not fully recovered, possibly due to migration into other cavities. However, mining-for-space could be rejuvenated in the Moab area.

2.4 Geologic and Seismologic Stability

In order for Atlas' reclamation plan to provide reasonable assurance of control of radiological hazards for 200 to 1000 years, it has to assess all significant geologic and seismologic conditions and processes that might affect the long-term stability of the pile (NRC, 1993).

2.4.1 Bedrock Stability

The following potential sources of bedrock instabilities beneath the site have been identified: main Moab fault, West Branch of Moab fault, buried scarp, bedrock surface topography, ground subsidence, and earthquakes. Other sources, such as potential faults similar to those exposed across Highway 191 that are attributed to tension across the crest of the Moab anticline, are not specifically under consideration because the effects of instability sources under consideration are likely to be bounding, for purposes of attaining reasonable assurance of an acceptable design.

2.4.1.1 Moab Fault System

If the Moab fault system is tectonically active and it contains one capable fault, then all structurally related faults (e.g., West Branch and main Moab faults) would be considered capable faults (*Code of Federal Regulations*, Part 100, Appendix A). Capable faults are considered to be capable of generating earthquakes and, in the case of the Atlas site, could offset the tailings and radon and erosion protective barriers.

If the Moab fault or the West Branch fault is a capable fault, then the resulting estimated seismic load on the pile would be larger than expected from other likely sources (Section 2.4.3). Secondary effects of faulting of such a capable fault would possibly include liquefaction. If neither of these faults is a capable fault, then they would not be considered in the seismic hazard analysis. However, they might generate displacements if they were reactivated by salt tectonics (i.e., landslide slip surfaces).

Recent mapping in the Moab quadrangle by UGS has suggested that the Moab fault and the West Branch of the Moab fault are rooted in the Moab salt-cored anticline (Doelling, et al., in press). If this is so, the Moab fault (and related faults of the Moab fault system, such as the West Branch fault) would not be considered to be a capable fault by definition of *Code of Federal Regulations*, 10 CFR Part 100, Appendix A. Nevertheless, the Moab Fault could still be a hazard to the site that must be assessed.

UGS and USGS geologists consider that surface subsidence by creep or dissolutioning is continuing, but at a rate reduced since the Pleistocene, when climate conditions were wetter. Doelling (in Allison, 1994) considers that subsidence by salt creep or dissolutioning is concentrated on faults near

the margins of the salt anticlines. He cites V-synclines along valley margins as evidence for this. The West Branch fault is favorably situated for this type of movement. The staff believes that Atlas must address the likelihood that the tailings pile will be subject to subsidence during the next 1000 years.

Future subsidence under the Atlas tailings by salt creep or dissolutioning could be concentrated on faults which apparently are rooted in the Moab salt-cored anticline (the Moab fault and the West Branch of the Moab fault could be examples of such faults). Such slip could produce landslides of the large magnitude described in Baars and Doelling (1987). Thus, the staff believes that Atlas must address the Moab fault (if it exists beneath the pile) and the West Branch of the Moab fault (considered to exist beneath the pile) as candidates for solution-related displacement during the next 1000 years.

The information that has been provided by Atlas and which the staff has obtained from other sources has not enabled the staff to reach a conclusion about whether or not the Moab fault is a capable fault. A conclusion on this critical issue is expected to be reached upon review of Atlas' analyses of its borehole data, historical photographs, field observations, seismic reflection surveys and review of the UGS's map of the Moab 7.5' quadrangle (Doelling, et al., in press). At this time the staff considers it to be an open issue as to whether or not the Moab fault is a capable fault. However, the staff's analysis of the seismic potential is currently based on the assumption that the Moab fault is not a capable fault (Section 2.4.3). This analysis would have to be revised if the Moab fault was found to be a capable fault.

2.4.1.2 Buried Scarp

The potential occurrence of an arcuate buried fault scarp beneath the southern edge of the tailings, parallel to the Colorado River channel, faulted down to the east, was recently developed by UGS (Doelling, et al., in press). The evidence for this feature's existence is based on Atlas borehole logs (Dames and Moore, 1987). The staff reviewed the evidence and considers that alternative concepts of a bedrock-surface drop-off are feasible, for example, a buried erosional escarpment, a buried stream channel or wash. The scarp, if it exists, is a consideration for pile design regardless of its origin. The distribution of thickness of alluvium beneath the pile varies fairly abruptly at and above the location of the scarp. Alluvium thickness distribution (geometry of the alluvial wedge above bedrock) is a factor in the consideration of attenuation of vibratory ground motion and in assessing differential subsidence.

If the feature is a fault scarp, its identification as a capable fault or not, and its relationship to the Moab fault system, would need to be assessed. The nature of faulting under the pile would be complicated if this feature were a fault. Such a fault would likely intersect either or both the Moab fault and the West Branch, pressing the need to know the relative ages of the faults. Also, if it is trending northeasterly, it would be parallel to the Colorado River seismic zone, which is currently seismogenic. If the scarp is erosional, it would suggest considerable aggradation of the Colorado River or substantial local subsidence in the same period. However, such an origin

would preclude it from being a seismic source or the locus of fault displacement.

The information provided by UGS on the buried fault under the site is insufficient for the staff to reach a conclusion on whether or not the buried fault is a capable fault and whether or not it is a fault at all. A conclusion is expected to be reached on this issue upon review of Atlas' analyses of its borehole data and seismic reflection survey. At this time the nature of the buried fault or scarp is an open issue.

2.4.1.3 Subsidence

Regional and local aseismic subsidence by rapid collapse or by slow downwarping or tilting is a consideration at the Atlas site (Blubaugh, 1994). However, the various effects of subsidence, their rates and magnitudes, have not yet been assessed by Atlas.

The sinkhole-like features mapped by UGS and related to rapid collapse in Castle Valley are attributed to salt dissolution (Mulvey, 1992). The features are not widespread in Castle Valley and have not been described from Moab-Spanish Valley or any other salt-cored anticlinal valley in Utah. Such a phenomenon, should it occur, would be a hazard to radon and erosion barriers. However, the likelihood of such a phenomenon occurring in Moab Valley, under the pile and breaching the radon and erosion barriers causing significant adverse effects, appears to be low.

If regional rates of incision, denudation and subsidence described in Section 2.3.3.2 are applicable to Moab Valley, then a rate of about 1-3 feet per 1000 years would be an appropriate design consideration. The applicability of such an indirectly estimated rate, its significance for pile design, and its attendant uncertainties (e.g., they are long-term averages and may be unconservative values; rates in Moab Valley could be notably higher for some reason not yet recognized) would need to be addressed.

The information provided by Atlas and that obtained from other sources suggests that subsidence under the pile is likely to occur during the next 1000 years. However, the information is not specific to the Atlas site. The staff is presently unable to conclude what an appropriate design basis for subsidence should be. It is expected that a conclusion about this critical issue will be reached upon review of Atlas' analyses of its borehole data, terrace profiling study, field observations of soils on stream terraces, and reassessment of critical data. At this time, the nature and rate of future subsidence at the site is an open issue.

2.4.2 Geomorphic Stability

The Atlas site is vulnerable to geomorphic hazards because it is: at the confluence of two active watercourses, Moab Wash and the Colorado River; at the base of an actively retreating 1100-feet-relief escarpment; in a basin of accumulating sediments, including those of eolian origin and infrequent volcanic ash falls. Also, in this category of hazards, the staff has considered the potential for subsidence due to future nearby mining, and oil

and gas extraction. Atlas provided adequate information regarding migration of the Colorado River, diversion of Moab Wash, rock falls, potash mining, and oil and gas extraction. These have been reviewed, and the attendant issues are satisfactorily resolved. Atlas is investigating migrating sand dunes and landslides, these issues remain open. The issue of volcanic ash hazard is resolved without need for input from Atlas.

2.4.2.1 Migrating Sand Dunes

Sand dunes, sand ramps, and sand sheets exist near the site. Observations of several sand ramps, including one near the entrance to Arches N.P., indicate lack of soil and vegetation and presence of ripples which imply that they are active. In the next 1000 years it is considered likely by the staff that similar dunes, ramps, and sheets will be deposited on or near the site, potentially affecting the performance of the erosion barrier or drainage of the pile, pile slopes or drainage systems related to pile stability. Wind patterns have been shown not to be an adverse concern for pile stability or dispersal of tailings {verify URFOs sign-off}. Atlas is assessing this issue.

Preliminary consideration by the staff suggests that the rates and amounts of transient and trapped sand are not likely to significantly affect the design of the slopes, barriers and drainage system. However, the information that the staff has obtained on the issue of sand migration onto the site during the next 1000 years is insufficient to reach a conclusion about the rate and quantities that would likely be involved. Atlas' analysis of future potential for sand migration is expected to provide an adequate basis for resolution of this issue. However, at this time the issue is open.

2.4.2.2 Mass Wasting: Rock Falls and Landslides

The retreat of the Poison Spider Mesa escarpment above the site apparently occurs mainly by rock falls and landslides followed by transport by running water of the rocks and debris that fell or slid to the base of the escarpment. Such geomorphic landslides need to be distinguished at this site from salt tectonic landslides (Section 2.4.1.1). The specific concern about geomorphic landslides is that slip could occur on the West Branch fault, or on other shears or extensive joints exposed on the Poison Spider Mesa escarpment. Such a landslide was mapped there by Huntoon, et al. (1982), but has not been corroborated by subsequent mapping (Doelling, et al., in press). Landslides above the tailings, in addition to rock falls, might interfere with drainage systems around the pile, or possibly encroach onto the erosion barrier itself (Section 4.5.1.3.2). Atlas is assessing the geomorphic landslide hazard.

Information provided by Atlas on the issue of rock falls that might encroach upon the drainage channels has been evaluated by the staff. The staff concluded that the mitigative design measures proposed to alleviate the effects of the rock fall hazard are adequate and consider this issue resolved. However, the staff has insufficient information on which to reach a conclusion about the hazard from landslides from the escarpment. It is expected that a conclusion about this issue will be reached upon review of Atlas' analyses of its field observations and other information regarding landslide potential emanating from the escarpment adjacent to the pile. At this time, landslide

hazard is an open issue.

2.4.2.3 Volcanic Ash Fall

The Quaternary sources of volcanic ash that accumulated in Arches N.P., and possibly in Fisher Valley, are still active and are potential volcanic ash hazards to the site. The potential concerns are that volcanic ash deposits could disrupt drainage channels by clogging, could promote gullying by subsequent runoff, and could change the protection capability of rip-rap by filling in voids in the rock cover. The actual consequences of ash fall onto a reclaimed pile are not known. Certain beneficial effects can be envisioned, for example, retardation of radon in the ash blanket. Also, ash fall in this area has a low probability of recurrence (approximately twice in 740,000 years). The potential for certain conditions at a volcanic source (e.g., large volume of ash having ascended to great height) and in the troposphere (e.g., sustained winds directed at Moab) would combine to produce significant ash fall onto the pile or into its drainage system is estimated to be low, and it is unclear what mitigative measures should be required to confront an ash fall situation at the Atlas tailings.

The staff considers the likelihood of the volcanic ash hazard to be too low to be a significant concern at the Atlas site. This issue is considered resolved.

2.4.2.4 Potash Mining

The potential for potash exploration and solution mining and potential effects of related technologies on the tailings have been discussed by Atlas (Norman, 1995a). The report provided direct and indirect evidence that the presence of economic deposits of potash and related minerals beneath the site is unlikely. Furthermore, title to the reclaimed site will revert to DOE or the state of Utah (Section 83 of Atomic Energy Act). This title transfer provides NRC with the authority to disallow mineral mining rights or other uses of the subsurface. Therefore, should natural resources be discovered beneath or near the pile site in the future, the integrity of the pile foundation could be protected from any adverse impact of a mining operation by withdrawal or non-issuance of the surface mineral mining rights.

The staff considers that potential future mining at or near the site need not be a design basis. The potash mining issue is considered resolved.

2.4.2.5 Oil and Gas

The potential for oil and gas exploration and extraction and potential effects of related technologies on the tailings have been discussed by Atlas (Norman, 1995b). This issue has a similar resolution as the potash mining issue discussed above (Section 2.4.2.4). Basically, there is little reason to consider direct intrusion into the pile, or subsidence at the pile from nearby extraction or dissolution of salt around boreholes, or that the future landowner (DOE or the state Utah) would permit exploration or extraction.

The staff considers that potential oil or gas exploration and extraction at or

near the site need not be a design basis. The oil/gas exploration/extraction issue is considered resolved.

2.4.3 Seismotectonic Stability

As a result of NRC staff review and evaluation of the geologic and seismologic information, and discussions with individuals at the state, Federal, and private levels knowledgeable of the region, the staff has determined that the licensee has not adequately addressed the seismic issue nor identified the maximum credible earthquake that could occur at the site.

In order to identify the seismic design for the site, Criterion 4 of Appendix A to Part 40 requires consideration of the maximum credible earthquake as defined in Appendix A to Part 100. Criterion 6 of Appendix A to Part 40 requires that the disposal cell be designed to remain stable for 1000 years to the extent reasonably achievable but in any case for at least 200 years. The maximum credible earthquake will provide a design seismic event that also meets the Criterion 6 requirement.

The staff evaluated[1] the seismicity of the area around the Atlas site and found that the only significant random earthquake in the Colorado Plateau occurred on November 7, 1882, in the northwest corner of Colorado. The magnitude of the earthquake as estimated by McGuire, et al. (1982) was 6.5. The epicenter of the earthquake was located about 200 km north-northeast of the site. This is the largest earthquake which has been reported within 250 km of the Atlas site. The staff concluded that this earthquake is associated with the Colorado Plateau, and that a magnitude 6.5 event is the appropriate floating earthquake that needs to be considered in design.

The other potentially significant seismic source of earthquakes is the northeast-trending feature along the Colorado River north of the confluence with the Green River. Wong and Humphrey (1989) located several seismic events in this area along the Colorado River. The focal depths of these earthquakes range from shallow up to about approximately 50 km (Figure 2-1). Considering that these earthquakes may be associated with the basement faulting, the staff estimated (Figure 2-2) that the length of the basement fault could be approximately 50 km. A reasonable estimate of a seismic event from this fault would consider only one-half of the fault length to rupture in any one event. Based on the relation developed by Wells and Coppersmith [1994, Figure 14, (a), which is the most recent work on this subject found by the staff], the staff estimated the magnitude resulting from a 25 km subsurface rupture on this fault to be 6.5. If the total length of the fault, 50 km, were to rupture, the magnitude would be approximately 7.0. This earthquake represents the largest and the closest event to the site.

In an independent study sponsored by NRC, Bernreuter, et al. (1995) performed

[1]For the purposes of this evaluation, the staff considers the Moab fault not to be capable. Atlas is currently in the process of conducting studies to determine the character of the Moab fault. The staff's final determination on seismotectonic stability will be dependent on the results of those studies.

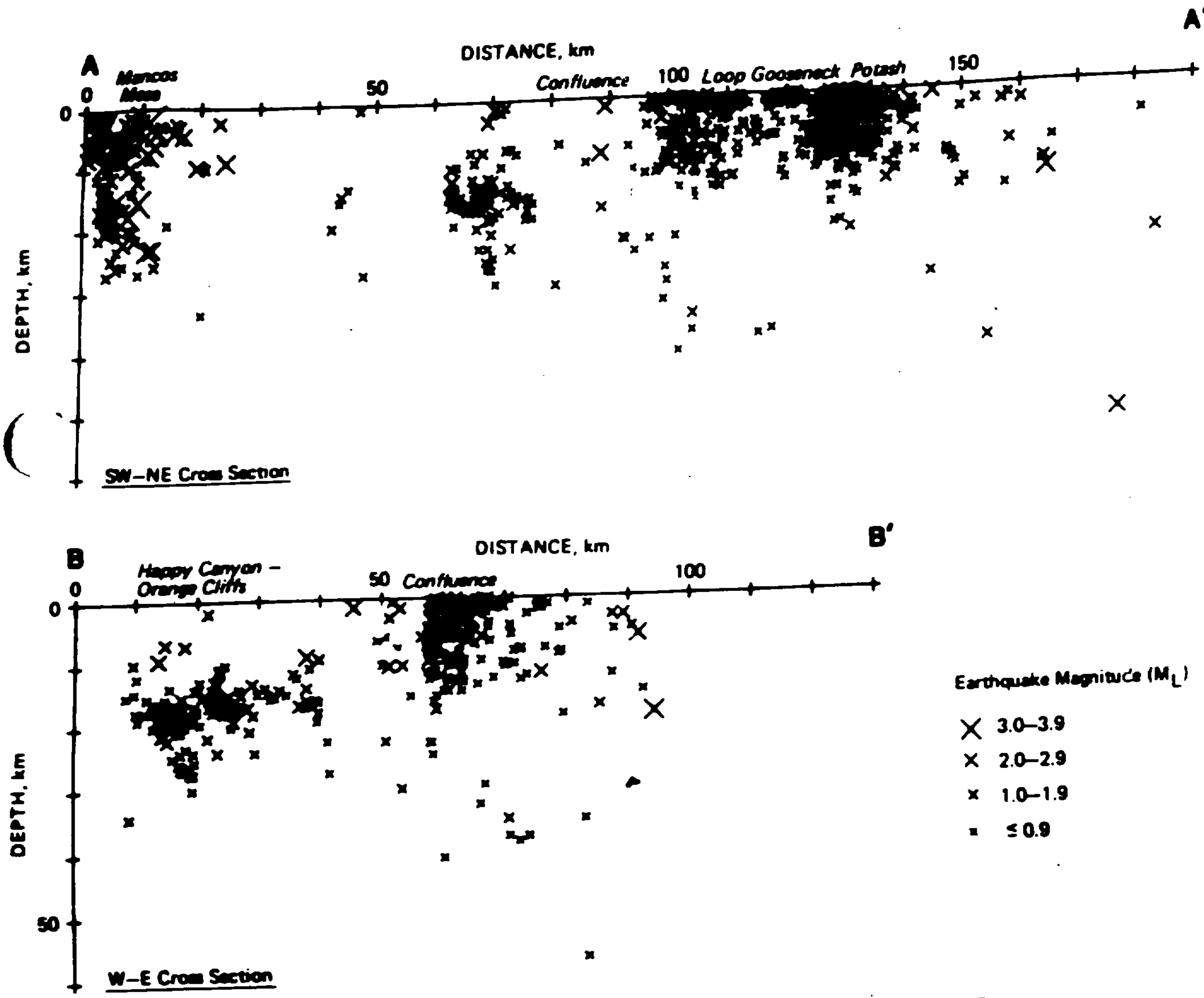

Figure 8. Seismicity cross sections through the Canyonlands region keyed to Figure 5.

FROM WONG AND HUMPHREY (1989)

Figure 2-1

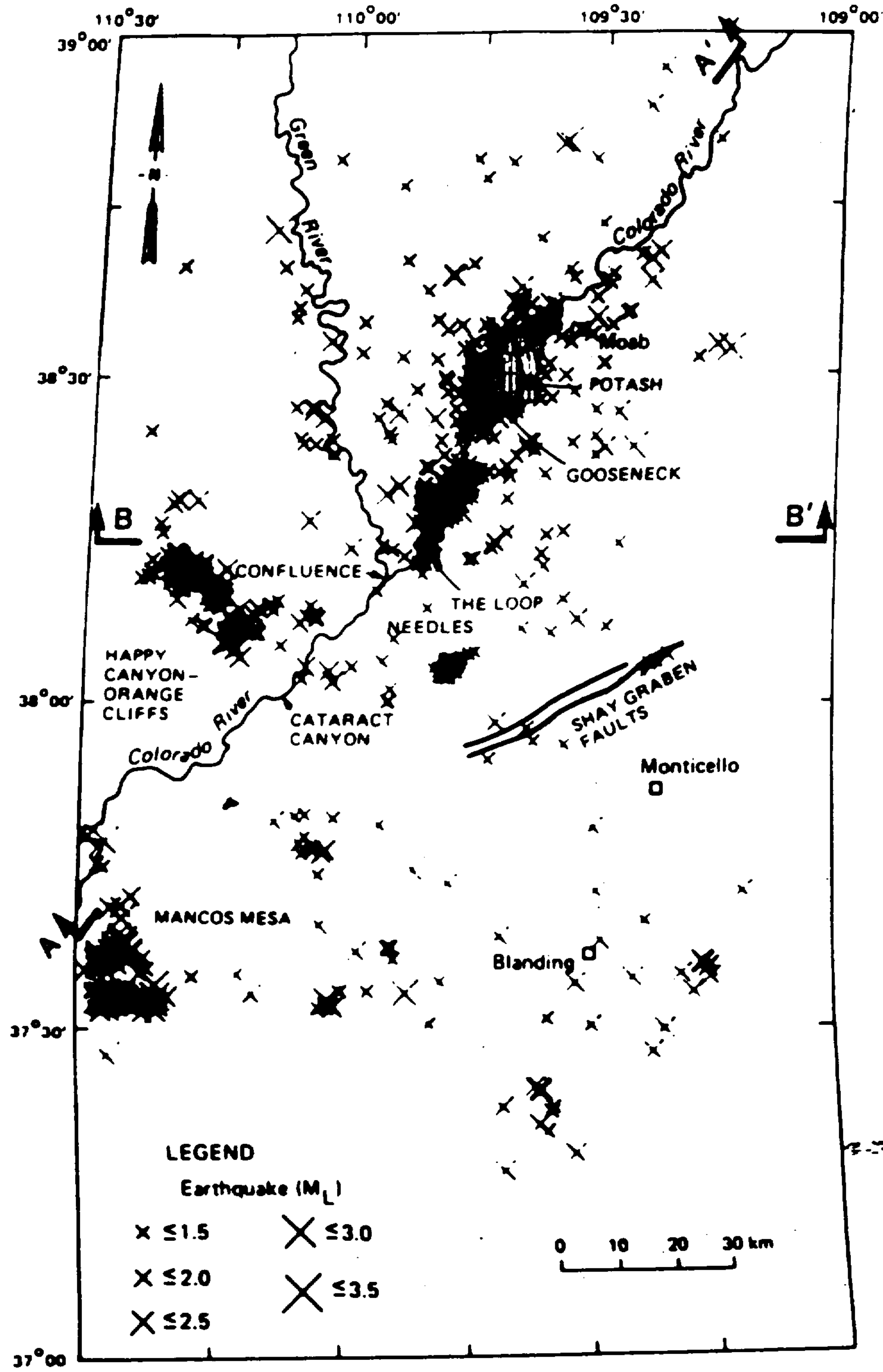

Figure 5. Seismicity of the Canyonlands region, July 1979 through July 1987. A–A' and B–B' indicate the locations of cross sections shown in Figure 8.

Figure 2-2: FROM WONG AND HUMPHREY (1989)

a simplified seismic hazard analysis for all Title II reclamation plans. The Atlas site was one of those examined. Bernreuter, et al. (1995) reviewed published and unpublished data, and discussed several issues dealing with the seismic hazards at Atlas with several organizations. Bernreuter, et al. (1995) concluded that: 1) The Moab fault is a surficial expression of underlying salt solution and is a subsidence feature rather than a tectonic feature; and 2) The seismicity along the Colorado River suggests that a basement fault exists under the river and could generate an earthquake of magnitude ranging from 5.5 to 7.0. Bernreuter, et al., estimated the peak ground acceleration at the Atlas site from such fault to range from 0.2g to 0.4g. Bernreuter, et al., used the Joyner and Boore (1982) attenuation model to estimate the acceleration at the site.

Geologic and seismologic information and investigations presented by the licensee as required by Part 40, Appendix A, did not provide sufficient information on the interrelation between seismicity and the basement fault north of the confluence of the Colorado and Green Rivers. For example, the licensee did not identify the maximum earthquake that could be generated from that fault.

Therefore, based on NRC staff review of the applicant's submittal and other relevant information, it was concluded that a reasonable estimate of the maximum credible earthquake for the Atlas site is a magnitude 6.5 event generated from a 25 km rupture of the inferred fault along the Colorado River at a distance of 5 km (the closet approach of the fault to the site).

In order to evaluate the capability of the proposed reclamation plan design to withstand this event (see Section 3), the resulting acceleration at the site must be estimated. The staff used Boore, et al. (1993) attenuation model to estimate the acceleration. This model is the most recent available model in the literature. Based on Boore, et al. (1993) attenuation relation, for an earthquake of magnitude 6.5 at distance of 5 km and a depth of 8 km, the acceleration value is 0.37g. This value is consistent with Bernreuter, et al., (1995) estimated values. The staff used the Boore, et al. (1993) attenuation model rather than the Joyner and Boore (1982) model used by Bernreuter, et al., because the 1993 model is based on updated data from recent earthquakes. In estimating the acceleration from Boore, et al. (1993), the staff assumed the shear velocity at the site ranges from 180 m/s to 360 m/s.

2.5 Conclusions

2.5.1 Bedrock Stability Issues

Atlas' consideration of bedrock stability is not acceptable because it has not demonstrated that geologic processes associated with faulting and subsidence at the site are adequately estimated or bounded to enable the staff to conclude with reasonable assurance that the requirements of 10 CFR Part 40 will be met.

CAPABLE FAULT. Specifically, the design basis issue of whether or not the Moab fault and the West Branch fault are capable faults is OPEN.

BURIED SCARP. Specifically, the design basis issue of whether or not the buried scarp is a capable fault, an aseismic fault or an erosional feature is OPEN.

SUBSIDENCE. Specifically, the design basis issue of what rate the pile is expected to subside during the next 1000 years, what cumulative amount, and how it will happen (e.g., on faults, by collapse, uniform settling) is OPEN.

VIBRATORY GROUND MOTION. Specifically, the design basis issue of what is the seismic load is OPEN.

2.5.2 Geomorphic Stability Issues

Atlas' consideration of geomorphic stability is partially acceptable because it has not demonstrated that geomorphic processes associated with eolian and mass wasting-landslide events have been adequately estimated or bounded to enable the staff to conclude with reasonable assurance that compliance with 10 CFR Part 40 requirements will be met.

MIGRATING SAND DUNES. Specifically, the design basis issue of whether or not, or in what way, migrating sand dunes might adversely affect the tailings during the next 1000 years is OPEN.

LANDSLIDES. Specifically, for landslides that might emanate from Poison Spider Mesa escarpment, the design basis issue of whether or not a potential landslide hazard exists, and to what extent landslides might disrupt the stability of the pile during the next 1000 years is OPEN.

VOLCANIC ASH FALL. Specifically, the issue of whether or not the potential volcanic ash fall hazard during the next 1000 years should be considered in pile design is RESOLVED. Volcanic ash fall is not a required design basis.

POTASH MINING. Specifically, the issue of whether or not potash solution mining beneath or near the pile during the next 1000 years should be considered in pile design is RESOLVED. Potash and other mineral mining is not a required design basis.

OIL AND GAS. Specifically, the issue of whether or not oil and gas exploration or extraction beneath or near the pile during the next 1000 years should be considered in pile design is RESOLVED. Oil and gas exploration/extraction is not a required design basis.

2.6 References

Allison, M.L., 1994. Letter to J.J. Holonich dated October 27, 1994, on Utah Geological Survey responses to October 7, 1994 NRC Questions on Atlas Corporation Mill Site, Moab, Utah.

Anderson, L.W., and D.G. Miller, compilers, 1979. Quaternary fault map of Utah: Fugro Inc., Long Beach CA, 35p.

Baars, D.L. and H.H. Doelling, 1987. Moab salt-intruded anticline, east-

central Utah: Geol. Soc. America Cent. Field Guide-Rocky Mtn. Sect., 275-280.

Bernreuter, D., McDermott, and Wagnor, J., 1995. Seismic Hazard analysis of Title II Reclamation Plans, Lawrence Livermore National Laboratory, Livermore, Ca.

Blubaugh, R., 1994. Letter to Holonich containing responses to NRC comments on the Moab fault, Utah.

Boore, D. M., Joyner, W. B., and Fumal, T. E., 1993. Estimation of response spectra and peak accelerations from western north america earthquakes: An interim report, U. S. Geological Survey, Open-File-Report 93-509, 72p.

Case, J.E. and H.R. Joesting, 1972. Regional geophysical investigations on the central Colorado Plateau: U.S. Geol. Surv. Prof. Paper 736, 31p.

Cater, F.W., 1970. Geology of the Salt Anticline Region in Southwestern Colorado: U.S. Geol. Surv. Prof. Paper 637, 75p.

Code of Federal Regulations, 10 CFR Part 40, Appendix A. Criteria relating to the operation of uranium mills and the disposition of tailings or wastes produced by the extraction or concentration of source material from ores processed primarily for their source material content.

Code of Federal Regulations, 10 CFR Part 100, Appendix A. Seismic and Geologic Siting Criteria for Nuclear Power Plants.

Coleman, S.M., 1983, Influence of the Onion Creek salt diapir on the late Cenozoic history of Fisher Valley, southeastern Utah: Geology, v. 11, 240-243.

Cruikshank, K.M. and A. Aydin, 1995. Unweaving the joints in Entrada Sandstone, Arches National Park, Utah, U.S.A: Jour. Structural Geol., v. 17, no. 3, 409-421.

Dames and Moore, 1987. Report showing depth to bedrock beneath Atlas site {____}

Doelling, H.H., 1985. Geology of Arches National Park: Utah Geol. Mineral Surv., to accompany Map 74, 15p.+ map.

Doelling, H.H., 1988. Geology of Salt Valley anticline and Arches National Park, Grand County, Utah: Utah Geol. and Mineral Surv. Bull. 122, 1-58.

Doelling, H.H., 1993. Interim Geologic Map, Moab 30' x 60' Quadrangle, Grand County Utah and Mesa County, Colorado: Utah Geol. Surv. Open-file Rept. 287.

Doelling, H.H., Ross, M.L. and W.E. Mulvey, in press, Interim Geologic Map of the Moab (7.5') Quadrangle, Grand County, Utah: Utah Geol. Surv.

Friedman, J.D., J.E. Case and S.L. Simpson, 1994. Tectonic trends of the northern part of the Paradox Basin, southeastern Utah and southwestern

Colorado, as derived from Landsat multispectral scanner imaging and geophysical and geologic mapping: U.S. Geol. Surv. Bull. 2000-C, C1-C30.

Harden, D.R., N.E. Biggar, and M.L. Gillam, 1985. Quaternary deposits and soils in and around Spanish Valley, Utah: Geol. Soc. America, Spec. Paper 203, 43-64.

Hecker, S., 1993. Quaternary tectonics of Utah with Emphasis on Earthquake-Hazard Characterization: Utah Geol. Surv. Bull. 127, 157p.

Hite, R.J., 1975. An unusual northeast-trending fracture zone and its relations to basement wrench faulting in northern Paradox Basin, Utah and Colorado: Four Corners Geol. Soc. Guidebk., 8th field conf., Canyonlands, 217-223.

Holonich, J.J., 1994. Letter to R. Blubaugh dated November 4, 1994, Request for Information for the Revised Reclamation Plan Review.

Hunt, C.B., 1956. Cenozoic geology of the Colorado Plateau: U.S. Geol. Surv. Prof. Paper 279, 99p.

Hunt, C.B., 1969. Geologic history of the Colorado River, the Colorado River region and John Wesley Powell: U.S. Geol. Surv. Prof. Paper 669-C, 59-130.

Hunt, C.B., 1974. "Natural Regions of the United States and Canada:" W.H. Freeman and Co., San Francisco, CA.

Huntoon, P.W., G.H. Billingsley, Jr. and W.J. Breed, 1982. Geologic map of Canyonlands National Park and vicinity, Utah.

Joesting, H.R., and J.E. Case, 1960. Salt anticlines and deep-seated structures in the Paradox Basin, Colorado and Utah: U.S. Geol. Surv. Research 1960, B252-B256.

Joyner, W. B., and Boore, 1982. Prediction of earthquake response spectra, Proc. 51st Ann. Convention Structural Eng. Assoc.of Cal., Also U. S. Geological Survey Open-File-Report 82-977, 16p.

McGuire, R. K., Krusi, A., and Oaks, S. D., 1982. The Colorado earthquake of November 7, 1882: size, epicentral location, intensities, and possible causative fault, The Mountain Geologist, V. 19, pp. 11-23.

McKnight, E.T., 1940. Geology of areas between Green and Colorado Rivers, Grand and San Juan Cos., Utah: U.S. Geol. Surv. Bull. 908.

Molenaar, C.M., 1975. Lexicon of stratigraphic names used in the Paradox Basin-San Rafael-Henry Mountains area, Utah: Four Corners Geol. Soc. Guidebk., 8th field conf., Canyonlands, 5-11.

Morgan, C.D., 1992. Horizontal drilling for oil and gas in the Moab area: Survey Notes, Utah Geol. Surv., v.25, no.2, p.10.

Morgan, C.D., W.A. Yonkee, and D.T. Tripp, 1991. Geological considerations for oil and gas drilling on state potash leases at Cane Creek anticline, Grand and San Juan Counties, Utah: Utah Geol. Surv. Circ. 84, 24p.

Morton, L.B., 1995. Letter to P. Justus, dated February 7, 1995, transmitting records of surface elevation surveys of Cane Creek potash mine.

Mulvey, W.E., 1992. Geologic hazards of Castle Valley, Grand Co., Utah: Utah Geol. Surv. Open-file Rept. 238, 31p.

Norman, R.R., 1995a. Potash Investigations - response to Nuclear Regulatory Commission request for information, potential effects of future salt extraction, Atlas Corp. uranium mill tailings site, Moab, Utah, 46p.

Norman, R.R., 1995b. Oil and gas investigations - response to Nuclear Regulatory Commission request for information, potential effects of future oil extraction, Atlas Corp., uranium mill tailings site, Moab, Utah: 43p.

NRC, 1993. Final Standard Review Plan for the Review and Remedial Action of Inactive Mill Tailings Sites under Title I of the Uranium Mill Tailings Radiation Control Act, Revision 1. June, 1993.

Oviatt, C.G., 1988. Evidence for Quaternary deformation in the Salt Valley anticline, southeastern Utah: Utah Geol. Mineral Surv. Bull. 122, 61-76.

Ross, M.L., in press. Geology of the Tertiary intrusive centers of the La Sal Mountains, Utah: influence of pre-existing structural features on emplacement and morphology: U.S. Geol. Surv. Bull., Friedman, J.D. and A.C. Huffman, coord., Laccolith complexes of southeastern Utah: time of emplacement and tectonic setting--workshop proceedings.

Safety Analysis Report, 1975. Atlas Mineral Division, Atlas Corporation, Moab, Utah.

Stevinson, G.M., and Baars, D.L., 1986, The Paradox pull-apart basin, Pennsylvanian rejuvenation of basement lineaments (abs.): 5th Internat. Conf. on Basement Tectonics, Proc., p. 310.

Sugiura, R. and C.A. Kitcho, 1981. Collapse structures in the Paradox Basin: Rocky Mtn. Assoc. Geol., 1981 Field Conf., 33-45.

Verbeek, E.R. and M.A. Grout, in press. Relation between basement structures and fracture systems in cover rocks, northeastern and southwestern Colorado Plateau: U.S. Geol. Surv. Bull., Friedman, J.D. and A.C. Huffman, coord., Laccolith complexes of southeastern Utah: time of emplacement and tectonic setting--workshop proc.

Weir, G.W., W.P. Puffett and C.L. Dodson, 1961. Collapse structures of southern Spanish Valley, southeastern Utah: U.S. Geol. Surv. Prof. Paper 424-B, 173-175.

Wells, D. L., and Coppersmith, K. J., 1994. New empirical relations among

magnitude, rupture, length, rupture width, rupture area, and surface displacement, Bulletin Seismological Society of America,, V. 84, pp. 974-1002.

Williams, P.L., 1964. Geology, structure, and uranium deposits of the Moab quadrangle, Colorado and Utah: U.S. Geol. Surv. Map I-360.

Wong, I.G. and Humphrey, J.R., 1989. Contemporary seismicity, faulting, and the state of stress in the Colorado Plateau: Geol. Soc. America Bull., v.101, 1127-1146.

Wong, I. G., Humphrey, J. R., and Simon, R., 1983. Contemporary Seismic and tectonics of the Colorado Plateau interior, Earthquake Notes, V. 54, p. 100.

Woodward-Clyde, 1982a. Geologic characterization report for the Paradox Basin study region, Utah study areas, vol. I: ONWI-290.

Woodward-Clyde, 1982b. Geologic characterization report for the Paradox Basin study region, Utah study areas; vol. IV: ONWI-290

Woodward-Clyde, 1994. Responses to NRC Comments on the Moab Fault, Utah. 26 May 1994.

3.0 GEOTECHNICAL STABILITY

3.1 Introduction

This section presents the results of the NRC staff review of the geotechnical engineering aspects of the closure action proposed at Atlas' Moab, Utah, mill site. The closure action consists of the consolidation of all contaminated materials from the processing site to the adjacent tailings pile near Moab, Utah. The final disposal cell will be an above-grade stabilized-in-place embankment extending to a maximum height of 110 feet above the prevailing surface grade. Contaminated material and mill debris will be added to the disposal cell. The cell will be recontoured as shown in Drawing No. 88-067-A112 (Canonie, 1995), and will be covered with a 7-foot-thick minimum sand cover, plus filter layer and rock armor on the embankment; a 39-inch-thick multiple layer cover plus rock armor over coarse tailings; and a 37-inch-thick multiple layer cover plus rock armor over at least seven feet of regraded coarse tailings over the fine tailings portions of the embankment.

The geotechnical engineering aspects reviewed include: (1) information related to the disposal and borrow sites; (2) materials associated with the closure action, including the foundation and excavation materials, tailings, and other contaminated materials; and (3) design and construction details related to the disposal site, disposal cell, and its cover. The staff evaluation of related topics such as geology, geomorphology, and seismic characterization, are presented in Section 2.

3.2 Site and Material Characterization

3.2.1 Site Description

The 130-acre impoundment (Figure 1-1) is adjacent to the former Atlas mill, about 3 miles northwest of the town of Moab, Utah. The site is located within the Moab Valley, and is drained by Moab Wash (an ephemeral channel) and the Colorado River. The uranium mill tailings were placed in a single pile consisting of approximately 10.5 million tons. The 130-acre pile forms a deposit with a maximum height of 110 feet. The Atlas Corporation has covered the sides of the pile with an interim soil cover of variable thickness. As the water in the pond atop the tailings has evaporated, additional interim cover has been placed on portions of the top of the pile, working from the edges inward toward the center.

The former mill area is 200 acres in size and contains building foundations and abandoned mill structures which have been partially demolished. Additional contaminated soil lies outside the confines of the tailings pile. The contaminated soil and building rubble generated from the mill demolition will be added to the disposal cell.

3.2.2 Geotechnical Investigations

3.2.2.1 Disposal Cell Area

Several subsurface investigations have been performed at the Atlas processing site in order to characterize the tailings and contaminated materials for

geotechnical engineering and radiological aspects of the closure. The licensee submitted a report, dated May 29, 1981, by Dames & Moore (1981) that contained drawings illustrating the original test boring and test pit locations. Logs of soil and test pits were provided in the licensee's earlier submittals (Dames & Moore, 1977; and Dames & Moore, 1979). Additional test pits were excavated in August 1988, and January 1992, within the confines of the mill and the tailings embankment. Test pit logs of these borings were initially reported in Appendix A of the licensee's June 4, 1992, submittal (Canonie, 1992) and modified in a later submittal (Canonie, 1993).

Exploration to depth within the tailings embankment was not previously performed since an active evaporation pond provided an obstacle to drill rig access. To further characterize the tailings, and to evaluate the embankment with respect to stability and potential settlement, the licensee has agreed to perform piezocone tests during construction. The piezocone, or Cone Penetration Test (CPT), is an instrument which measures the piezometric pressure at a cone tip as the device penetrates a material. CPT pore pressures, thus measured, reflect both the soil type and the stress history of the material. CPT test data will be considered along with settlement records to better evaluate the time-rate of tailings consolidation.

3.2.2.2 Borrow Areas

The licensee submitted an evaluation of the proposed radon barrier clay soils to be obtained from the Klondike Flats area. The evaluation was documented in a report prepared by Canonie Environmental Services Corp. (Canonie, 19??). The Klondike Flats borrow area is located about 13.8 miles north of the tailings pile.

Sandy soil for the radon barrier will be obtained from material excavated during the reconfiguration of Moab Wash (see Section 4). In 1988 and 1992, 15 exploratory test pits were excavated in the Moab Wash area.

Finally, in addition to the sampling associated with the reconfiguration of Moab Wash, the licensee analyzed three additional samples taken from the proposed borrow area located west of the tailings cell on the Atlas property.

3.2.2.3 Geotechnical Investigation Conclusions

The NRC staff has reviewed the subsurface exploration discussed above. The staff concludes that, with the exception of tailings characterization, the geotechnical investigations conducted at the processing, disposal, and borrow sites satisfactorily establish the stratigraphy, that the explorations are in general conformance with applicable provisions of Chapter 2 of the SRP (NRC, 1993), and that they are adequate to support the assessment of the geotechnical stability of the stabilized tailings and contaminated material in the disposal cell. In order to complete the characterization of the tailings and the settlement analysis, the licensee needs to submit additional piezocone information. Prior to approval of the settlement evaluation, the licensee should submit a field exploration plan for the piezocone exploration program. This is an OPEN ISSUE.

3.2.3 Testing Program

Geotechnical engineering characteristics and strength parameters for the tailings, contaminated soil, and natural soils have been determined by the licensee through laboratory analysis of samples from these investigations. Early laboratory testing by Dames & Moore, and later testing by Canonie Environmental, included moisture-density (Proctor) determinations, gradation analyses, specific gravity, saturated hydraulic conductivity determinations, Atterberg Limits, capillary moisture, one-dimensional consolidation, static triaxial, and cyclic triaxial compression. The staff has reviewed the geotechnical engineering testing program for the Atlas site and concludes that the tests identified above were conducted on representative materials.

The licensee's laboratory testing of the Klondike Flats borrow material included gradation, Atterberg Limits, moisture-density determination, specific gravity, saturated hydraulic conductivity, capillary moisture relationships, dispersive tendencies, diffusion coefficient, and triaxial shear strength. The licensee states that additional tests will be made on the borrow soils during construction to confirm conformance with the project specifications. The construction specifications must be revised accordingly.

Within the Moab Wash area, one composite sample was made from the "affected" (contaminated) sandy soils. A second sample was made from "clean" soils (see Section 6.2.1 for additional information). The composite samples were then split into three subsamples, and were redivided for geotechnical and radiological sampling. Laboratory testing by the licensee included gradation, Atterberg Limits, moisture-density relationships, specific gravity, diffusion coefficient, and (for the "affected" soils) radium activity and emanation coefficient determination. Three composite samples from west of the tailings pile area were tested for gradation, Atterberg Limits, moisture-density relationships, specific gravity, diffusion coefficient, and capillary moisture relationship.

Proposed cover materials were evaluated for durability. Testing included Los Angeles Abrasion, sulfate soundness, absorption, specific gravity, Schmidt Hammer, and Brazilian disk tensile tests. Petrographic analyses were also conducted. Further discussion regarding the tests on proposed cover materials is presented in Section 4.

On the basis of the field exploration and laboratory testing programs, the licensee concluded that the proposed borrow sites contain suitable quantities of material acceptable for the proposed radon barrier. Testing indicated the soils are non-dispersive.

Based on the review, NRC staff finds that the number and type of tests conducted in the testing program were appropriate for the support of the engineering analyses performed and that the scope of the testing program and the utilization of the test results to define the material properties are in general agreement with the applicable provisions of the SRP (NRC, 1993).

3.3 Geotechnical Engineering Evaluation

3.3.1 Slope Stability

The evaluation of the geotechnical stability of the slopes of the disposal cell containing stabilized tailings and other contaminated materials is presented in this section. The staff has reviewed the exploration data, test results, slope characteristics, and methods of analyses pertinent to the slope stability aspects of the reclamation plan. The analyzed cross-sections with 10 horizontal to 3 vertical side slopes have been compared with the exploratory records and design details. The staff finds that the characteristics of the slopes have been satisfactorily represented and that the most critical slope sections have been considered for stability analyses.

Soil parameters for the various materials in the disposal cell slope have been adequately established by appropriate testing of representative materials. Soil parameter values have been assigned to other layers (riprap, gravel bedding, bedrock, etc.) by the licensee, on the basis of data obtained from geotechnical explorations at the site and data published in the literature. The staff finds that the determinations of these parameters for slope stability evaluation follow conventional geotechnical engineering practice, and are also in compliance with the applicable provisions of Chapter 2 of the SRP (NRC, 1993). The staff also finds that an appropriate method of stability analysis (Simplified Bishop method) has been employed by the licensee to address the likely extreme adverse conditions to which the slope might be subjected for the static case.

Factors of safety against failure of the slope for static and seismic loading conditions have been determined by the licensee for both short-term (end of construction) and long-term states. Factors of safety for the static loading conditions were calculated by the licensee to be 1.6 (short- and long-term) which are in excess of minimum required values of 1.3 and 1.5, respectively.

The seismic stability of the slope was investigated by the licensee using the pseudo-static method of analysis, with horizontal seismic coefficients of 0.21 for both the end-of-construction case and for the long-term case. The values of the seismic coefficients were selected by considering the design ground acceleration value used for the nearby Green River Title I site. In actuality, a horizontal seismic coefficient equal to 0.67 times the maximum ground acceleration, or 0.14g, would be used in a pseudo-static evaluation, thus the licensee's model is over-conservative for this case.

In addition, slope stability was evaluated by the Licensee using the pseudo-static method and a horizontal seismic coefficient of 0.25. The use of a horizontal seismic coefficient of 0.25 would imply a maximum ground acceleration of about 0.38g; however, the pseudo-static method of analysis is inappropriate for that high an acceleration. If the stability design based on a Peak Ground Acceleration (PGA) value of 0.37g is considered, then the pseudo-static analysis is invalid for this case, and a deformation analysis would be required.

Based on review of these analyses and the results, the staff cannot conclude that the slopes of the disposal cell are designed to endure the effects of the geologic processes and events, including resistance to earthquake and

settlement, to which they may reasonably be subjected during the design life and that the analyses have been made in a manner consistent with Chapter 2 of the SRP (NRC, 1993). This is an OPEN ISSUE. The licensee has indicated that it is in the process of conducting a deformation analysis. Staff approval of this aspect of design will depend on a satisfactory review of the deformation analysis work now in progress.

3.3.2 Settlement and Cover Cracking

Long-term settlement of materials in the disposal cell, which could result in either local depressions or cracks on top of the cover, was addressed by the licensee in Canonie Environmental's report of June 4, 1992. A proposed settlement monitoring program was provided. Settlement monuments will be installed directly on the tailings prior to the initiation of regrading activities. Construction equipment will be required to maintain a minimum distance of 5 feet from all monuments.

The monuments will be surveyed for vertical displacement on a daily basis for the first 2 weeks of initial fill placement, weekly for the following 2 months, and then monthly for the final 2 months. When the licensee has concluded that 90 percent of the consolidation settlement is complete, and with NRC's concurrence, final soil cover placement operations can begin.

Settlement monuments will be located in areas where consolidation is expected to be the greatest, including areas believed to have maximum thicknesses of fine tailings. Such an arrangement should ensure that differential settlement will not adversely affect the integrity of the cover. Additionally, the final soil cover will be spread and compacted in a uniform manner to minimize the effects of settlement due to the weight of the final soil cover materials. The licensee concluded that 90 percent of the primary consolidation should take 1 to 2 years, based on the fact that there has been no disposal of tailings since 1984 and that the pumping program conducted at the site has accelerated the dewatering process.

In addition, the licensee will conduct an exploration program within the embankment using piezocones. The piezocone data will be evaluated along with settlement records to confirm the conclusion that 90 percent of the expected settlement has occurred. The piezocone test results can also be used to assess the potential for cover cracking. Subject to confirmation testing in the piezocone exploration stage, the proposed settlement monitoring program is considered sufficient to satisfy applicable portions of Criteria 1, 6, and 12, of Part 40, Appendix A, regarding reclamation design to control radiological hazards for the design life without active maintenance after reclamation is complete. In particular, assurance that the long-term isolation of tailings without ongoing maintenance, and protection of the environment from the harmful effects of radiation, must be provided.

3.3.3 Liquefaction Potential

The liquefaction potential for the Atlas site was initially evaluated by Dames & Moore, as reported in their correspondence dated February 16, 1979. Dames & Moore evaluated the liquefaction potential based on empirical techniques and on the basis of a laboratory evaluation. Minimum factors of safety of 1.69 (empirical) and 1.90 (laboratory) were derived in the Dames & Moore study.

Based on the similarity in results, and considering minimum acceptable safety factors of 1.5, Dames & Moore concluded that no major problem related to liquefaction would occur during the postulated seismic event, which they considered to be a Magnitude 6 event with a hypocentral distance of approximately 50 km and a maximum ground acceleration of 0.08g.

Our understanding of the seismic hazard and liquefaction process has improved since 1979. Based on more recent interpretations of potential seismic events, and in accordance with a November 4, 1994, request from the NRC, the licensee is currently reevaluating the liquefaction potential for the site. The licensee stated on January 24, 1995, that liquefaction would be re-evaluated using existing blowcounts, gradation, and sample descriptions from previous analyses with updated empirical relationships for liquefaction potential. The induced stresses will be estimated from simplified procedures and/or from one- or two-dimensional response analyses. If required, the computer programs SHAKE or FLUSH will be used. The staff's liquefaction analysis review has been suspended until the licensee's reevaluation is complete and the results are made available. Thus, staff cannot conclude that there is adequate assurance of safety with respect to liquefaction damage. This is an **OPEN ISSUE**.

3.3.4 Cover Design

The licensee has proposed three different embankment cover sections, depending on location:

1) The proposed final cover profile for the embankment will consist of 7 feet (minimum) of sandy soil above the regraded coarse tailings. The sandy soil will be capped by a filter layer and rock armor of variable thickness.

2) The proposed cover profile over coarse tailings will consist of:

   6 inches (minimum) of low-grade ore from the mill area,
   16 inches (minimum) of affected soil,
   8 inches (minimum) of compacted clay,
   9 inches of sandy soil

   The coarse tailings areas will be covered with rock armor of variable thickness.

3) The proposed cover profile over fine tailings will include:

   7 feet (minimum) of regraded coarse tailings,
   16 inches (minimum) of affected soil,
   12 inches (minimum) of compacted clay,
   9 inches (minimum) of sandy soil

   A rock armor of variable thickness will cover the sandy soil.

The cover system described above will provide 37 inches of cover above the fine tailings and 39 inches of cover above the coarse tailings on the top and sides of the cell. The system has been designed to limit the infiltration of precipitation, protect the pile from erosion, and to control the release of

radon from the tailings below. Details of the staff's review of the cover's performance related to limiting infiltration are addressed in Section 5 of this report; the review of the cover's erosion protection features is presented in Section 4, and the review of the radon attenuation aspects of the cover is presented in Section 6. Certain other design aspects of the proposed cover are discussed herein.

Tests on the compacted clay from Klondike Flats indicate that hydraulic conductivities will be near 10^{-7} cm/sec at placement conditions. In addition, the physical shape and surface grading of the reclaimed tailings embankment will effectively remove surface water resulting from precipitation which falls on the area. The relatively low permeability of the cover materials and the low annual rainfall with high evaporation rate will serve to prevent significant tailings recharge.

The licensee has evaluated the potential for frost penetration using the BERGGREN.BAS computer code developed at the U.S. Army Corps of Engineers (COE, 1968). The code has been used on several other uranium mill tailings remediation projects. In order to evaluate the potential for frost penetration, temperature data including the freezing index, mean annual air temperature, length of freezing season, and geotechnical parameters are considered. The model calculates the heat capacity, thermal conductivity, and latent heat of fusion for the soil layers unless these data are entered manually.

Values used in the computer analysis included the mean and worst-case situations based on 31 years of weather records. In the worst-case scenario, the licensee determined that the depth of frost penetration would be 10.2 inches. By thickening the sand layer to 9 inches, and in conjunction with the exterior rock armor, the potential for frost penetration into the clay layer is eliminated, and the cover integrity should not be substantially affected.

The staff has reviewed the input data used in determining the total frost penetration depth and concludes that these values are a reasonable representation of the extreme site conditions to be expected. Therefore, the licensee's evaluation of the frost penetration depth is acceptable to the staff.

The cover design has been evaluated by the staff for geotechnical long-term stability and the design is acceptable; however, it is required that the licensee perform materials testing during construction and revise the cover design if needed. The radon attenuation ability of the cover is discussed in Section 6 and the hydraulic conductivity aspects of the cover in Section 5.

3.4 Geotechnical Construction Details

3.4.1 Construction Methods and Features

The staff has reviewed and evaluated the geotechnical construction criteria provided in the Reclamation Plan. Based on this review, the staff concludes that the plans and drawings clearly convey the proposed closure action design features. In addition, the excavation and placement methods and specifications are consistent with accepted standard practice.

3.4.2 Testing and Inspection

The staff has reviewed and evaluated the testing and inspection quality control requirements provided in the Technical Specifications (Canonie, 1992) in the Reclamation Plan. Although the plan is found to provide a program for testing and inspection that is generally consistent with the Staff Technical Position on Testing and Inspection (NRC, 1989), certain aspects are deficient. Portions of the technical specifications have been superseded by later submittals, such as the revised cover design; however, the specifications have not been updated to reflect these revisions. The technical specifications need to be consistent with the reclamation design. This is an OPEN ISSUE.

Section 4 of the technical specifications permits the placement of fill in 18-inch-thick lifts; however, such lift thicknesses make uniform compaction difficult to achieve. For this reason, the licensee should either specify more workable lift thicknesses or describe applicable procedures for verifying that thorough compaction has been achieved. This is an OPEN ISSUE.

3.5 Conclusions

Based on the review of the geotechnical engineering aspects of the design of the Atlas closure action as presented in the Reclamation Plan, the staff concludes that the embankment and proposed borrow soils have been adequately characterized, with the exception of confirming settlement potential within the embankment. Furthermore, the cover system appears to be adequately designed to resist the effects of freezing conditions which can reasonably be expected. However, the staff can not conclude that the geotechnical engineering aspects of the proposed design meet the requirements in Appendix A of Part 40 until the following open items are resolved:

1. In order to complete the characterization of the tailings and the settlement analysis, the licensee needs to submit additional piezocone information. Prior to approval of the settlement evaluation, the licensee should submit a field exploration plan for the piezocone exploration program.

2. The staff cannot conclude that the slopes of the disposal cell are designed to endure the effects of the geologic processes and events, including resistance to earthquake and settlement, to which they may reasonably be subjected during the design life and that the analyses have been made in a manner consistent with Chapter 2 of the SRP (NRC, 1993).

3. The licensee is currently reevaluating the liquefaction potential for the site. The staff's liquefaction analysis review has been suspended until the licensee's reevaluation is complete and the results are made available. Thus, the staff cannot conclude that there is adequate assurance of safety with respect to liquefaction damage.

4. Portions of the technical specifications have been superseded by later submittals, such as the revised cover design; however, the specifications have not been updated to reflect these revisions. The technical specifications need to be consistent with the reclamation design.

5. The specifications permit the placement of fill in 18-inch-thick lifts; however, such lift thicknesses make uniform compaction difficult to achieve. The licensee should either specify more workable lift thicknesses or describe applicable procedures for verifying that thorough compaction has been achieved.

SECTION 3 - REFERENCES

Safety Analysis Report, 1975. Atlas Mineral Division, Atlas Corporation, Moab, Utah.

Tailings Management and Reclamation Alternatives Study for Atlas Minerals at Moab, Utah, revised, 1977, Dames & Moore

Report of Supplementary Study, Geotechnical Evaluation of Tailings Pond - Embankment System, Moab, Utah, for Atlas Minerals, 1979, Dames & Moore

Report of Stability Analysis - 18-foot Raise of Tailings Embankment to Elevation 4076 feet, Moab, Utah, 1981, Dames & Moore

Atlas Corporation, "Reclamation Plan Uranium Mill and Tailings Disposal Area," January, 1992.

Atlas Corporation, "Reclamation Plan Uranium Mill and Tailings Disposal Area," January, 1994.

Atlas Corporation, "Reclamation Plan Uranium Mill and Tailings Disposal Area," March, 1995.

NRC, 1993, Final Standard Review Plan for the Review and Remedial Action of Inactive Mill Tailings Sites under Title I of the Uranium Mill Tailings Radiation Control Act, Revision 1: U.S. Nuclear Regulatory Commission, June 1993.

Bernreuter, D., McDermott, and Wagnor, J., 1995. Seismic Hazard analysis of Title II Reclamation Plans, Lawrence Livermore National Laboratory, Livermore, Ca.

3.0 GEOTECHNICAL STABILITY

3.1 Introduction

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The geotechnical engineering aspects reviewed include: (1) information related to the disposal and borrow sites; (2) materials associated with the closure action, including the foundation and excavation materials, tailings, and other contaminated materials; and (3) design and construction details related to the disposal site, disposal cell, and its cover. The staff evaluation of related topics such as geology, geomorphology, and seismic characterization, are presented in Section 2.

3.2 Site and Material Characterization

3.2.1 Site Description

The 130-acre impoundment (Figure 1-1) is adjacent to the former Atlas mill, about 3 miles northwest of the town of Moab, Utah. The site is located within the Moab Valley, and is drained by Moab Wash (an ephemeral channel) and the Colorado River. The uranium mill tailings were placed in a single pile consisting of approximately 10.5 million tons. The 130-acre pile forms a deposit with a maximum height of 110 feet. The Atlas Corporation has covered the sides of the pile with an interim soil cover of variable thickness. As the water in the pond atop the tailings has evaporated, additional interim cover has been placed on portions of the top of the pile, working from the edges inward toward the center.

The former mill area is 200 acres in size and contains building foundations and abandoned mill structures which have been partially demolished. Additional contaminated soil lies outside the confines of the tailings pile. The contaminated soil and building rubble generated from the mill demolition will be added to the disposal cell.

3.2.2 Geotechnical Investigations

3.2.2.1 Disposal Cell Area

Several subsurface investigations have been performed at the Atlas processing site in order to characterize the tailings and contaminated materials for

geotechnical engineering and radiological aspects of the closure. The licensee submitted a report, dated May 29, 1981, by Dames & Moore (1981) that contained drawings illustrating the original test boring and test pit locations. Logs of soil and test pits were provided in the licensee's earlier submittals (Dames & Moore, 1977; and Dames & Moore, 1979). Additional test pits were excavated in August 1988, and January 1992, within the confines of the mill and the tailings embankment. Test pit logs of these borings were initially reported in Appendix A of the licensee's June 4, 1992, submittal (Canonie, 1992) and modified in a later submittal (Canonie, 1993).

Exploration to depth within the tailings embankment was not previously performed since an active evaporation pond provided an obstacle to drill rig access. To further characterize the tailings, and to evaluate the embankment with respect to stability and potential settlement, the licensee has agreed to perform piezocone tests during construction. The piezocone, or Cone Penetration Test (CPT), is an instrument which measures the piezometric pressure at a cone tip as the device penetrates a material. CPT pore pressures, thus measured, reflect both the soil type and the stress history of the material. CPT test data will be considered along with settlement records to better evaluate the time-rate of tailings consolidation.

3.2.2.2 Borrow Areas

The licensee submitted an evaluation of the proposed radon barrier clay soils to be obtained from the Klondike Flats area. The evaluation was documented in a report prepared by Canonie Environmental Services Corp. (Canonie, 19??). The Klondike Flats borrow area is located about 13.8 miles north of the tailings pile.

Sandy soil for the radon barrier will be obtained from material excavated during the reconfiguration of Moab Wash (see Section 4). In 1988 and 1992, 15 exploratory test pits were excavated in the Moab Wash area.

Finally, in addition to the sampling associated with the reconfiguration of Moab Wash, the licensee analyzed three additional samples taken from the proposed borrow area located west of the tailings cell on the Atlas property.

3.2.2.3 Geotechnical Investigation Conclusions

The NRC staff has reviewed the subsurface exploration discussed above. The staff concludes that, with the exception of tailings characterization, the geotechnical investigations conducted at the processing, disposal, and borrow sites satisfactorily establish the stratigraphy, that the explorations are in general conformance with applicable provisions of Chapter 2 of the SRP (NRC, 1993), and that they are adequate to support the assessment of the geotechnical stability of the stabilized tailings and contaminated material in the disposal cell. In order to complete the characterization of the tailings and the settlement analysis, the licensee needs to submit additional piezocone information. Prior to approval of the settlement evaluation, the licensee should submit a field exploration plan for the piezocone exploration program. This is an OPEN ISSUE.

3.2.3 Testing Program

Geotechnical engineering characteristics and strength parameters for the tailings, contaminated soil, and natural soils have been determined by the licensee through laboratory analysis of samples from these investigations. Early laboratory testing by Dames & Moore, and later testing by Canonie Environmental, included moisture-density (Proctor) determinations, gradation analyses, specific gravity, saturated hydraulic conductivity determinations, Atterberg Limits, capillary moisture, one-dimensional consolidation, static triaxial, and cyclic triaxial compression. The staff has reviewed the geotechnical engineering testing program for the Atlas site and concludes that the tests identified above were conducted on representative materials.

The licensee's laboratory testing of the Klondike Flats borrow material included gradation, Atterberg Limits, moisture-density determination, specific gravity, saturated hydraulic conductivity, capillary moisture relationships, dispersive tendencies, diffusion coefficient, and triaxial shear strength. The licensee states that additional tests will be made on the borrow soils during construction to confirm conformance with the project specifications. The construction specifications must be revised accordingly.

Within the Moab Wash area, one composite sample was made from the "affected" (contaminated) sandy soils. A second sample was made from "clean" soils (see Section 6.2.1 for additional information). The composite samples were then split into three subsamples, and were redivided for geotechnical and radiological sampling. Laboratory testing by the licensee included gradation, Atterberg Limits, moisture-density relationships, specific gravity, diffusion coefficient, and (for the "affected" soils) radium activity and emanation coefficient determination. Three composite samples from west of the tailings pile area were tested for gradation, Atterberg Limits, moisture-density relationships, specific gravity, diffusion coefficient, and capillary moisture relationship.

Proposed cover materials were evaluated for durability. Testing included Los Angeles Abrasion, sulfate soundness, absorption, specific gravity, Schmidt Hammer, and Brazilian disk tensile tests. Petrographic analyses were also conducted. Further discussion regarding the tests on proposed cover materials is presented in Section 4.

On the basis of the field exploration and laboratory testing programs, the licensee concluded that the proposed borrow sites contain suitable quantities of material acceptable for the proposed radon barrier. Testing indicated the soils are non-dispersive.

Based on the review, NRC staff finds that the number and type of tests conducted in the testing program were appropriate for the support of the engineering analyses performed and that the scope of the testing program and the utilization of the test results to define the material properties are in general agreement with the applicable provisions of the SRP (NRC, 1993).

3.3 Geotechnical Engineering Evaluation

3.3.1 Slope Stability

The evaluation of the geotechnical stability of the slopes of the disposal cell containing stabilized tailings and other contaminated materials is presented in this section. The staff has reviewed the exploration data, test results, slope characteristics, and methods of analyses pertinent to the slope stability aspects of the reclamation plan. The analyzed cross-sections with 10 horizontal to 3 vertical side slopes have been compared with the exploratory records and design details. The staff finds that the characteristics of the slopes have been satisfactorily represented and that the most critical slope sections have been considered for stability analyses.

Soil parameters for the various materials in the disposal cell slope have been adequately established by appropriate testing of representative materials. Soil parameter values have been assigned to other layers (riprap, gravel bedding, bedrock, etc.) by the licensee, on the basis of data obtained from geotechnical explorations at the site and data published in the literature. The staff finds that the determinations of these parameters for slope stability evaluation follow conventional geotechnical engineering practice, and are also in compliance with the applicable provisions of Chapter 2 of the SRP (NRC, 1993). The staff also finds that an appropriate method of stability analysis (Simplified Bishop method) has been employed by the licensee to address the likely extreme adverse conditions to which the slope might be subjected for the static case.

Factors of safety against failure of the slope for static and seismic loading conditions have been determined by the licensee for both short-term (end of construction) and long-term states. Factors of safety for the static loading conditions were calculated by the licensee to be 1.6 (short- and long-term) which are in excess of minimum required values of 1.3 and 1.5, respectively.

The seismic stability of the slope was investigated by the licensee using the pseudo-static method of analysis, with horizontal seismic coefficients of 0.21 for both the end-of-construction case and for the long-term case. The values of the seismic coefficients were selected by considering the design ground acceleration value used for the nearby Green River Title I site. In actuality, a horizontal seismic coefficient equal to 0.67 times the maximum ground acceleration, or 0.14g, would be used in a pseudo-static evaluation, thus the licensee's model is over-conservative for this case.

In addition, slope stability was evaluated by the Licensee using the pseudo-static method and a horizontal seismic coefficient of 0.25. The use of a horizontal seismic coefficient of 0.25 would imply a maximum ground acceleration of about 0.38g; however, the pseudo-static method of analysis is inappropriate for that high an acceleration. If the stability design based on a Peak Ground Acceleration (PGA) value of 0.37g is considered, then the pseudo-static analysis is invalid for this case, and a deformation analysis would be required.

Based on review of these analyses and the results, the staff cannot conclude that the slopes of the disposal cell are designed to endure the effects of the geologic processes and events, including resistance to earthquake and

settlement, to which they may reasonably be subjected during the design life and that the analyses have been made in a manner consistent with Chapter 2 of the SRP (NRC, 1993). This is an OPEN ISSUE. The licensee has indicated that it is in the process of conducting a deformation analysis. Staff approval of this aspect of design will depend on a satisfactory review of the deformation analysis work now in progress.

3.3.2 Settlement and Cover Cracking

Long-term settlement of materials in the disposal cell, which could result in either local depressions or cracks on top of the cover, was addressed by the licensee in Canonie Environmental's report of June 4, 1992. A proposed settlement monitoring program was provided. Settlement monuments will be installed directly on the tailings prior to the initiation of regrading activities. Construction equipment will be required to maintain a minimum distance of 5 feet from all monuments.

The monuments will be surveyed for vertical displacement on a daily basis for the first 2 weeks of initial fill placement, weekly for the following 2 months, and then monthly for the final 2 months. When the licensee has concluded that 90 percent of the consolidation settlement is complete, and with NRC's concurrence, final soil cover placement operations can begin.

Settlement monuments will be located in areas where consolidation is expected to be the greatest, including areas believed to have maximum thicknesses of fine tailings. Such an arrangement should ensure that differential settlement will not adversely affect the integrity of the cover. Additionally, the final soil cover will be spread and compacted in a uniform manner to minimize the effects of settlement due to the weight of the final soil cover materials. The licensee concluded that 90 percent of the primary consolidation should take 1 to 2 years, based on the fact that there has been no disposal of tailings since 1984 and that the pumping program conducted at the site has accelerated the dewatering process.

In addition, the licensee will conduct an exploration program within the embankment using piezocones. The piezocone data will be evaluated along with settlement records to confirm the conclusion that 90 percent of the expected settlement has occurred. The piezocone test results can also be used to assess the potential for cover cracking. Subject to confirmation testing in the piezocone exploration stage, the proposed settlement monitoring program is considered sufficient to satisfy applicable portions of Criteria 1, 6, and 12, of Part 40, Appendix A, regarding reclamation design to control radiological hazards for the design life without active maintenance after reclamation is complete. In particular, assurance that the long-term isolation of tailings without ongoing maintenance, and protection of the environment from the harmful effects of radiation, must be provided.

3.3.3 Liquefaction Potential

The liquefaction potential for the Atlas site was initially evaluated by Dames & Moore, as reported in their correspondence dated February 16, 1979. Dames & Moore evaluated the liquefaction potential based on empirical techniques and on the basis of a laboratory evaluation. Minimum factors of safety of 1.69 (empirical) and 1.90 (laboratory) were derived in the Dames & Moore study.

Based on the similarity in results, and considering minimum acceptable safety factors of 1.5, Dames & Moore concluded that no major problem related to liquefaction would occur during the postulated seismic event, which they considered to be a Magnitude 6 event with a hypocentral distance of approximately 50 km and a maximum ground acceleration of 0.08g.

Our understanding of the seismic hazard and liquefaction process has improved since 1979. Based on more recent interpretations of potential seismic events, and in accordance with a November 4, 1994, request from the NRC, the licensee is currently reevaluating the liquefaction potential for the site. The licensee stated on January 24, 1995, that liquefaction would be re-evaluated using existing blowcounts, gradation, and sample descriptions from previous analyses with updated empirical relationships for liquefaction potential. The induced stresses will be estimated from simplified procedures and/or from one- or two-dimensional response analyses. If required, the computer programs SHAKE or FLUSH will be used. The staff's liquefaction analysis review has been suspended until the licensee's reevaluation is complete and the results are made available. Thus, staff cannot conclude that there is adequate assurance of safety with respect to liquefaction damage. This is an **OPEN ISSUE**.

3.3.4 Cover Design

The licensee has proposed three different embankment cover sections, depending on location:

1) The proposed final cover profile for the embankment will consist of 7 feet (minimum) of sandy soil above the regraded coarse tailings. The sandy soil will be capped by a filter layer and rock armor of variable thickness.

2) The proposed cover profile over coarse tailings will consist of:

   6 inches (minimum) of low-grade ore from the mill area,
   16 inches (minimum) of affected soil,
   8 inches (minimum) of compacted clay,
   9 inches of sandy soil

   The coarse tailings areas will be covered with rock armor of variable thickness.

3) The proposed cover profile over fine tailings will include:

   7 feet (minimum) of regraded coarse tailings,
   16 inches (minimum) of affected soil,
   12 inches (minimum) of compacted clay,
   9 inches (minimum) of sandy soil

   A rock armor of variable thickness will cover the sandy soil.

The cover system described above will provide 37 inches of cover above the fine tailings and 39 inches of cover above the coarse tailings on the top and sides of the cell. The system has been designed to limit the infiltration of precipitation, protect the pile from erosion, and to control the release of

radon from the tailings below. Details of the staff's review of the cover's performance related to limiting infiltration are addressed in Section 5 of this report; the review of the cover's erosion protection features is presented in Section 4, and the review of the radon attenuation aspects of the cover is presented in Section 6. Certain other design aspects of the proposed cover are discussed herein.

Tests on the compacted clay from Klondike Flats indicate that hydraulic conductivities will be near 10^{-7} cm/sec at placement conditions. In addition, the physical shape and surface grading of the reclaimed tailings embankment will effectively remove surface water resulting from precipitation which falls on the area. The relatively low permeability of the cover materials and the low annual rainfall with high evaporation rate will serve to prevent significant tailings recharge.

The licensee has evaluated the potential for frost penetration using the BERGGREN.BAS computer code developed at the U.S. Army Corps of Engineers (COE, 1968). The code has been used on several other uranium mill tailings remediation projects. In order to evaluate the potential for frost penetration, temperature data including the freezing index, mean annual air temperature, length of freezing season, and geotechnical parameters are considered. The model calculates the heat capacity, thermal conductivity, and latent heat of fusion for the soil layers unless these data are entered manually.

Values used in the computer analysis included the mean and worst-case situations based on 31 years of weather records. In the worst-case scenario, the licensee determined that the depth of frost penetration would be 10.2 inches. By thickening the sand layer to 9 inches, and in conjunction with the exterior rock armor, the potential for frost penetration into the clay layer is eliminated, and the cover integrity should not be substantially affected.

The staff has reviewed the input data used in determining the total frost penetration depth and concludes that these values are a reasonable representation of the extreme site conditions to be expected. Therefore, the licensee's evaluation of the frost penetration depth is acceptable to the staff.

The cover design has been evaluated by the staff for geotechnical long-term stability and the design is acceptable; however, it is required that the licensee perform materials testing during construction and revise the cover design if needed. The radon attenuation ability of the cover is discussed in Section 6 and the hydraulic conductivity aspects of the cover in Section 5.

3.4 Geotechnical Construction Details

3.4.1 Construction Methods and Features

The staff has reviewed and evaluated the geotechnical construction criteria provided in the Reclamation Plan. Based on this review, the staff concludes that the plans and drawings clearly convey the proposed closure action design features. In addition, the excavation and placement methods and specifications are consistent with accepted standard practice.

3.4.2 Testing and Inspection

The staff has reviewed and evaluated the testing and inspection quality control requirements provided in the Technical Specifications (Canonie, 1992) in the Reclamation Plan. Although the plan is found to provide a program for testing and inspection that is generally consistent with the Staff Technical Position on Testing and Inspection (NRC, 1989), certain aspects are deficient. Portions of the technical specifications have been superseded by later submittals, such as the revised cover design; however, the specifications have not been updated to reflect these revisions. The technical specifications need to be consistent with the reclamation design. This is an OPEN ISSUE.

Section 4 of the technical specifications permits the placement of fill in 18-inch-thick lifts; however, such lift thicknesses make uniform compaction difficult to achieve. For this reason, the licensee should either specify more workable lift thicknesses or describe applicable procedures for verifying that thorough compaction has been achieved. This is an OPEN ISSUE.

3.5 Conclusions

Based on the review of the geotechnical engineering aspects of the design of the Atlas closure action as presented in the Reclamation Plan, the staff concludes that the embankment and proposed borrow soils have been adequately characterized, with the exception of confirming settlement potential within the embankment. Furthermore, the cover system appears to be adequately designed to resist the effects of freezing conditions which can reasonably be expected. However, the staff can not conclude that the geotechnical engineering aspects of the proposed design meet the requirements in Appendix A of Part 40 until the following open items are resolved:

1. In order to complete the characterization of the tailings and the settlement analysis, the licensee needs to submit additional piezocone information. Prior to approval of the settlement evaluation, the licensee should submit a field exploration plan for the piezocone exploration program.

2. The staff cannot conclude that the slopes of the disposal cell are designed to endure the effects of the geologic processes and events, including resistance to earthquake and settlement, to which they may reasonably be subjected during the design life and that the analyses have been made in a manner consistent with Chapter 2 of the SRP (NRC, 1993).

3. The licensee is currently reevaluating the liquefaction potential for the site. The staff's liquefaction analysis review has been suspended until the licensee's reevaluation is complete and the results are made available. Thus, the staff cannot conclude that there is adequate assurance of safety with respect to liquefaction damage.

4. Portions of the technical specifications have been superseded by later submittals, such as the revised cover design; however, the specifications have not been updated to reflect these revisions. The technical specifications need to be consistent with the reclamation design.

5. The specifications permit the placement of fill in 18-inch-thick lifts; however, such lift thicknesses make uniform compaction difficult to achieve. The licensee should either specify more workable lift thicknesses or describe applicable procedures for verifying that thorough compaction has been achieved.

SECTION 3 - REFERENCES

Safety Analysis Report, 1975. Atlas Mineral Division, Atlas Corporation, Moab, Utah.

Tailings Management and Reclamation Alternatives Study for Atlas Minerals at Moab, Utah, revised, 1977, Dames & Moore

Report of Supplementary Study, Geotechnical Evaluation of Tailings Pond - Embankment System, Moab, Utah, for Atlas Minerals, 1979, Dames & Moore

Report of Stability Analysis - 18-foot Raise of Tailings Embankment to Elevation 4076 feet, Moab, Utah, 1981, Dames & Moore

Atlas Corporation, "Reclamation Plan Uranium Mill and Tailings Disposal Area," January, 1992.

Atlas Corporation, "Reclamation Plan Uranium Mill and Tailings Disposal Area," January, 1994.

Atlas Corporation, "Reclamation Plan Uranium Mill and Tailings Disposal Area," March, 1995.

NRC, 1993, Final Standard Review Plan for the Review and Remedial Action of Inactive Mill Tailings Sites under Title I of the Uranium Mill Tailings Radiation Control Act, Revision 1: U.S. Nuclear Regulatory Commission, June 1993.

Bernreuter, D., McDermott, and Wagnor, J., 1995. Seismic Hazard analysis of Title II Reclamation Plans, Lawrence Livermore National Laboratory, Livermore, Ca.

4.0 SURFACE WATER HYDROLOGY AND EROSION PROTECTION

4.1 Introduction

This section of the TER describes the staff's review of surface water hydrology and erosion protection issues related to long-term stability. In this section, the staff provides the technical bases for the acceptability of the licensee's reclamation design. Review areas that are covered include: estimates of flood magnitudes; water surface elevations and velocities; sizing of riprap to be used for erosion protection; long-term durability of the erosion protection; and testing and inspection procedures to be implemented during construction.

4.2 Hydrologic Description and Site Conceptual Design

The Atlas tailings disposal area is located on a river terrace approximately 500 to 700 feet from the Colorado River and approximately 3 miles north of the town of Moab, Utah. Moab Wash, an ephemeral stream with a drainage area of about 5 square miles, is located along the north and east sides of the tailings impoundment. The site is surrounded by the near-vertical sandstone cliffs of the Moab Valley.

To comply with Criterion 6 of 10 CFR 40, Appendix A, which requires stability of the tailings for 1000 years to the extent reasonably achievable and in any case for 200 years, the licensee proposes to reclaim the tailings impoundment in place and to protect the tailings from flooding and erosion. The design basis events for design of erosion protection include the Probable Maximum Precipitation (PMP) and the Probable Maximum Flood (PMF) events, both of which are considered to have very low probabilities of occurring during the 1000-year stabilization period.

As shown in Figure 4-1, the top surface of the tailings impoundment will be reconfigured to drain toward three collection ditches, and the embankment side slopes will be flattened to 10H:3V except at the southwest corner where the slopes will be 10H:1V. The three collection ditches on the top surface will merge to form the Upper Impoundment Drainage Channel. This channel will convey flood runoff into the Lower Impoundment Drainage Channel, which will then discharge into Moab Wash. Moab Wash will be reconfigured to convey flood flows into the Colorado River east of the tailings pile. The Southwest Runoff Drainage Channel will divert runoff from the side slopes on the southwest side of the reclaimed impoundment and from the sandstone bluffs southwest of the channel.

To protect against erosion, the top and side slopes of the tailings impoundment will be covered with layers of rock riprap. At the toes of the side slopes, a riprap apron/toe will be constructed to provide protection against the potential migration of Moab Wash and the Colorado River. The collection ditches and drainage channels will also be protected with riprap.

For Moab Wash, the licensee proposes to excavate a new channel as far away from tailings as possible. The reconfigured channel will flow eastward across

Figure 4-1: Atlas erosion control features

the floodplain and into the Colorado River upstream of the site. The design will provide a shallow trapezoidal channel designed for the PMF. At approximately the center of the main channel, a low-flow channel will be constructed to convey flows up to the 200-year flood.

4.3 Flooding Determinations

The computation of peak flood discharges for various site design features and nearby hydrologic features was performed by the licensee in several steps. These steps included: (1) selection of a design rainfall event; (2) determination of infiltration losses; (3) determination of times of concentration; (4) determination of appropriate rainfall distributions, corresponding to the computed times of concentration; and (5) calculation of flood discharge. Input parameters were derived from each of these steps and were then used to determine the peak flood discharges to be used in water surface profile modelling (Section 4.4) and in the final determination of rock sizes for erosion protection (Section 4.5).

4.3.1 Selection of Design Rainfall Event

One of the phenomena most likely to affect long-term stability is surface

water erosion. To mitigate the potential effects of surface water erosion, the staff considers that it is very important to select an appropriately conservative rainfall event on which to base the flood protection designs. Further, the staff considers that the selection of a design flood event should not be based on the extrapolation of limited historical flood data, due to the unknown level of accuracy associated with such an extrapolation. The licensee utilized a PMP computed by deterministic methods (rather than statistical methods) and based on site-specific hydrometeorological characteristics. The PMP has been defined as the most severe reasonably possible rainfall event that could occur as a result of a combination of the most severe meteorological conditions occurring over a watershed. No recurrence interval is normally assigned to the PMP; however, the staff has concluded that the probability of such an event being equalled or exceeded during the 1000-year stability period is very low. Accordingly, the PMP is considered by the NRC staff to provide an acceptable design basis.

Prior to determining the runoff from the drainage basin, the flooding analysis requires the determination of PMP amounts for the specific site location. Techniques for determining the PMP have been developed for the United States by Federal agencies in the form of hydrometeorological reports for specific regions. These techniques are widely used and provide straightforward procedures with minimal variability. The staff, therefore, concludes that use of these reports to derive PMP estimates is acceptable.

PMP values were estimated by the licensee using Hydrometeorological Report No. 49 (HMR-49) (NOAA, 1977). The report provides information on distributing the rainfall that falls over a particular drainage area; during a PMP event these rainfall amounts vary inversely with the size of the area (the smaller the area the larger the average rainfall). A 1-hour PMP of 7.4 inches and a 6-hour PMP of 9.36 inches were used by the licensee as a basis for estimating a PMF for Moab Wash which has a drainage area of 5 square miles. For the smaller areas at the site such as the pile top, embankment side slopes, and the discharge channels, a 1-hour PMP of 8.25 inches was used. For the Colorado River, the licensee did not calculate the PMF using PMP values; rather, the licensee used existing PMF studies to estimate the PMF (See Section 4.3.5.5).

The licensee's procedures for estimating PMP values were reviewed, and it was concluded that a 1-hour PMP of 7.4 inches and a 6-hour PMP of 9.36 inches are acceptable for Moab Wash. For the other small drainage areas at the site, it was concluded that a 1-hour PMP of 8.25 inches was acceptable. Based on staff review of the rainfall computations, the staff concludes that the PMP was acceptably derived for this site.

4.3.2 Infiltration Losses

In addition to the amount of precipitation, the determination of the peak runoff rate is also dependent on the amount of precipitation that infiltrates into the ground during its occurrence and therefore does not contribute to flood flows. If the ground is saturated from previous rains, very little of the rainfall will infiltrate and most of it will become surface runoff. The loss rate is highly variable, depending on the vegetation and soil

characteristics of the watershed. Typically, all runoff models incorporate a variable runoff coefficient or variable runoff rates. Commonly-used models such as the United States Bureau of Reclamation (USBR) Rational Formula (USBR 1977) incorporate a runoff coefficient (C); a C value of 1 represents 100% runoff and no infiltration. Other models such as the U.S. Army Corps of Engineers Flood Hydrograph Package HEC-1 (COE 1988) separately compute infiltration losses within a certain period of time to arrive at a runoff amount during that time period.

In computing the peak flow rate for the small drainage areas at the site, the licensee used the Rational Formula (USBR 1977). In this formula, the runoff coefficient was assumed to be unity; that is, the licensee assumed that no infiltration would occur. Based on a review of the computations, the staff concludes that this is a conservative assumption and is, therefore, acceptable.

The licensee used HEC-1 to estimate PMF values for larger drainage areas such as the drainage channels and Moab Wash. Basin characteristics used as input parameters to HEC-1 were determined by the licensee using the United States Soil Conservation Service Curve Number (CN) Method (USBR 1977). The CN of an area is an indication of the amount of precipitation that will result in runoff. It is based on the soil and vegetation characteristics of a drainage area and on the soil moisture levels existing prior to the design storm event. In estimating CN values, the licensee assumed that the soil moisture at the beginning of the PMP event would be close to saturation. This resulted in conservative PMFs, because saturated soil conditions limit the amount of infiltration that will occur and maximize the amount of runoff.

4.3.3 Times of Concentration

The time of concentration (t_c) is the amount of time required for runoff to reach the outlet of a drainage basin from the most remote point in that basin. The peak runoff for a given drainage basin is inversely proportional to the time of concentration. If the time of concentration is computed to be small, the peak discharge will be conservatively large. Times of concentration and/or lag times are typically computed using empirical relationships such as those developed by Federal agencies (USBR 1977). Velocity-based approaches are also used when accurate estimates are needed. Such approaches rely on estimates of actual flow velocities to determine the time of concentration of a drainage basin.

Times of concentration for the riprap design were estimated by the licensee using several methods, such as the Kirpich Method (USBR 1977) and the Manning's Equation (Chow 1959). Such methods are generally accepted in engineering practice and are considered by the staff to be appropriate for estimating times of concentration. Based a review of the calculations provided, the staff concludes that the t_c values used by the licensee were acceptably derived.

4.3.4 Rainfall Distributions

After the PMP is determined, it is necessary to determine the rainfall

intensities corresponding to shorter rainfall durations and times of concentration. A typical PMP value is derived for periods of about one hour. If the time of concentration is less than one hour, it is necessary to extrapolate the data presented in the various hydrometeorological reports to shorter time periods. The licensee utilized a procedure recommended in HMR-49 (NOAA 1977) and by the NRC staff (NRC 1990). This procedure involves the determination of rainfall amounts as a percentage of the one-hour PMP, and computes rainfall amounts and intensities for very short periods of time

To determine peak flood flows for the pile (for a PMP of 8.25 inches), approximate PMP rainfall intensities were derived by the licensee as follows:

Rainfall Duration (minutes)	Rainfall Intensity (inches/hr)
2.5	54.5
5.0	44.5
15.0	24.4
60.0	8.25

The staff checked the rainfall intensities for the short durations associated with small drainage basins. Based on a review of this aspect of the flooding determination, the staff concludes that the computed peak rainfall intensities are acceptable.

The temporal distribution of rainfall is the sequence in which a storm occurs. For example, in some storms, such as the PMP in HMR-49, the largest increments of rainfall occur at the beginning of the storm and taper off as the rainfall continues. In other storms, rainfall begins slowly, increasing in intensity to a peak near the center of the storm duration before it begins to taper off. It has been shown that a rainfall distribution that peaks near the center of the storm duration results in the most conservative (largest) PMF peak discharge. In order to obtain conservative PMF estimates, the licensee resequenced the incremental rainfall amounts from HMR-49 so that the largest rainfall increments occurred near the center of the storm duration. The resequenced PMP amounts, CN values, t_c estimates and other parameters were then used in the HEC-1 computer program for calculating appropriate PMF peak discharges for the collection ditches, drainage channels, and Moab Wash. Based on its review of these aspects of the flood determinations, the staff concludes that appropriate rainfall distributions were used.

4.3.5 Computation of PMF

Various methods are used to determine peak PMF flows, depending on the location of the feature, the drainage area, and other factors.

4.3.5.1 Top and Side Slopes

To estimate PMF peak discharges for the impoundment top and embankment side slopes, the licensee used the Rational Method (Chow 1959). This method is a simple procedure for estimating flood discharges that is recommended in the

Staff Technical Position (STP) on Erosion Protection (NRC 1990). In using the Rational Method, the licensee conservatively assumed a runoff coefficient equal to one. This means that the entire PMP would result in runoff, i.e., there would be no losses due to infiltration and evapotranspiration.

For a maximum top slope length of 1440 feet (with a slope of 0.018) and a side slope length of 310 feet (with a slope of 0.3), the licensee estimated the peak flow rates to be about 1.0 cubic feet per second per foot of width (cfs/ft) for the top slope and 0.4 cfs/ft for the side slope. For the 10 percent slope at the extreme southern end of the pile, the peak flow rate was estimated to be 0.7 cfs/ft. Based on a review of the calculations, including the time of concentration, rainfall intensity, and runoff, the staff concludes that the estimates are acceptable.

4.3.5.2 Apron/Toe

PMF flow rates for overland flow for the downstream apron were estimated by the licensee and are similar to the flow rates for the side slopes. As discussed above, the flow rates are considered to be acceptable.

4.3.5.3 Collection Ditches and Drainage Channels

Peak PMF discharges for the collection ditches and drainage channels were estimated by the licensee using the HEC-1 computer program. The program was developed by the COE (COE 1988), and is a widely used and accepted procedure for estimating flood peak discharges. The method is recommended by the NRC staff (NRC 1990) and is therefore, acceptable.

Following is a summary of the licensee's calculated PMF peak discharges for the collection ditches, the Upper Impoundment Drainage Channel (UIDC), the Lower Impoundment Drainage Channel (LIDC), and the Southwest Diversion Channel (SWDC):

Channel	Drainage Area (square miles)	PMF (cfs)
Collection Ditch 1	.02	376
Collection Ditch 2	.03	482
Collection Ditch 3	.04	614
UIDC	.08	1638
LIDC	.09	1640
SWDC	.09	1723

The flow rate for the LIDC, for example, represents a discharge of about 18,000 cfs/mi^2. These flow rates were compared with published historic maximum flood rates (Crippen and Bue, 1977). Based on a review of the calculations and comparison with historic floods, the licensee's estimates are acceptable.

4.3.5.4 Moab Wash

To evaluate the adequacy of the licensee's estimated PMF peak discharge for Moab Wash, an independent calculation was performed by the NRC staff. Using the 1:24,000 scale map provided by the licensee, the staff first verified the licensee's estimate of the Moab Wash drainage area (5 square miles). The incremental PMP values were then arranged to provide the largest possible flood peak discharge. A curve number of 93 was then selected (see discussion of curve numbers above; a CN=100 would mean that 100 percent of the rainfall would result in runoff). Using HEC-1, the staff estimated a PMF peak discharge of 16,069 cfs. This compares favorably with the licensee's estimate of 15,129 cfs. Based on this close comparison, it was concluded that the licensee's PMF estimate for Moab Wash is acceptable.

4.3.5.5 Colorado River

The licensee did not independently estimate a PMF peak discharge for the Colorado River. Instead, existing flood data were reviewed and a search was conducted for additional studies of floods in the area. The review provided a range of Colorado River flood events that included the highest recorded flood, the 100-year, 200-year, and 500-year floods, and two estimates of the PMF. The highest recorded flow, as reported by the U.S. Geological Survey (USGS) for Moab, Utah, was 77,000 cfs in 1917. The USGS estimated 100-year, 200-year, and 500-year flood discharges of 99,500 cfs, 109,500 cfs, and 123,500 cfs, respectively. However, these estimates are for the nearest stream gaging station which is at Cisco, Utah, located about 35 miles upstream of Moab.

A PMF peak discharge (300,000 cfs) was previously estimated by the NRC staff. This estimate was developed by adjusting the Standard Project Flood estimate of the Corps of Engineers. As a result, it was recognized that the estimate was likely to be conservative. It was significantly higher, however, than the 178,000 cfs estimated by Dames & Moore and reported by Atlas in the May 1984 renewal application.

In reviewing the licensee's reported historic and estimated extreme flood peak discharges for the Colorado River, the NRC staff contacted the USBR. The USBR reported that they have not performed any comprehensive flood studies of the Colorado River at Moab, Utah. However, PMF reports are available for Hoover and Glen Canyon Dams, which are located on the Colorado River downstream of Moab (USBR 1990). The PMF developed for the Colorado River at Glen Canyon Dam had a peak discharge of 697,000 cfs. This is more than twice as large as the largest recorded flood in the Colorado River which occurred at the site of Hoover Dam in July of 1884. That flood had a peak discharge of about 300,000 cfs. The NRC staff recognizes that these studies are not applicable to the Moab site since the drainage areas at these dam sites are considerably larger; however, they can be used to obtain a rough estimate of a PMF at Moab. Chow states that, "In some homogeneous areas where t_c is a simple function of area, the peak rates will vary directly with some power of the area, usually 0.5 (Chow 1959)." The Colorado River at Glen Canyon Dam has a drainage area of 108,000 square miles (USBR 1990). By comparison, the drainage area for the Colorado River at Moab, Utah is about 25,000 square miles, according to the licensee's May 1984 renewal application. Using the Chow relationship, a rough estimate of the PMF for the Colorado River at Moab would be 335,300 cfs. Therefore, assuming a PMF peak discharge of 300,000 at Moab appears to be

reasonable and acceptable. This estimate was used by the licensee.

The staff's assessment of flood potential also included a review of paleoflood data for the Colorado River basin. These data were presented in "Paleoflood Evidence for a Natural Upper Bound to Flood Magnitudes in the Colorado River Basin" (Enzel, et. al, 1993). In this report, the authors indicate that the largest flood on the Colorado River occurred about 4000 years ago. This flood had a magnitude of about 495,000 cfs (14,000 cubic meters per second) at Lee's Ferry (Glen Canyon Dam), where the drainage area is about 108,000 square miles (279,000 square kilometers). This flood magnitude is less than the estimated PMF peak discharge of 697,000 cfs. No data were presented to estimate the magnitude of this historical flood at the site; however, using similar relationships to those discussed by Chow and discussed above, an approximate estimate of the maximum historical flood at the site (where the drainage area is about 25,000 square miles) would be approximately 238,000 cfs. This discharge is also less than the PMF estimate of 300,000 cfs.

4.4 Water Surface Profiles and Channel Velocities

Following the determination of the peak flood discharge, it is necessary to determine the resulting water levels, velocities, and shear stresses associated with that discharge. These parameters then provide the basis for the determination of the required riprap size and layer thickness needed to ensure stability during the occurrence of the design event.

4.4.1 Top and Side Slopes

In determining riprap requirements for the top and side slopes, the licensee used the Safety Factors Method (Stevens, et al., 1976) and the Stephenson Method (Stephenson, 1979), respectively. The Safety Factors Method is used for relatively flat slopes of less than 10 percent; the Stephenson Method is used for slopes greater than 10 percent. The validity of these design approaches has been verified by the NRC staff through the use of flume tests at Colorado State University. It was determined that the selection of an appropriate design procedure depends on the magnitude of the slope (Abt, et al., 1987). The staff, therefore, concludes that the procedures and design approaches used by the licensee are acceptable and reflect state-of-the-art methods for designing riprap erosion protection. Input parameters and design methods for riprap sizing are discussed further in Section 4.5.

4.4.2 Apron/Toe

The design of the apron/toe for this site must be adequate to withstand forces from several different phenomena and is based on the following general concepts: (1) provide riprap of adequate size to be stable against overland (downslope) flows produced by the design storm (PMP), with allowances for turbulence along the downstream portion of the toe; (2) provide uniform and/or gentle grades along the apron and the adjacent ground surface such that runoff is distributed uniformly onto natural ground at a relatively low velocity, minimizing the potential for flow concentration and erosion; (3) provide riprap of adequate size to withstand expected peak flow velocities and scour in Moab Wash, assuming that the channel has eroded and is located in the

immediate area of the toe; (4) provide riprap to resist the highest velocities and shear forces expected in the Colorado River channel (such velocities and shear forces may not occur during the PMF, but may occur at lesser river flows where the backwater effects of the Portal area are not present); and (5) provide an adequate apron length and quantity of rock to allow the rock apron to collapse into a stable configuration if the main channel of the Colorado River eroded toward the site.

Several analytical methods were used for designing the riprap for the apron/toe, depending on its location relative to Moab Wash and the Colorado River. Additional detailed discussion of the riprap design of various components of the apron/toe can be found in Section 4.5.1.2, below.

4.4.3 Collection Ditches and Drainage Channels

Using the PMF peak discharges discussed above, flood control features such as collection ditches and drainage channels were designed by the licensee. For the trapezoidal-shaped ditches and channels with little variation in slope or shape, the licensee determined water surface elevations and flow velocities associated with the PMF peak discharges by calculating normal depth (Chow 1959). Normal depth calculations are generally acceptable for the design of riprap erosion protection. In some cases, flow profiles and velocities were calculated by the licensee using the computer program HEC-2 (COE 1991). This method is considered to be an acceptable computational method for estimating water surface elevations, flow depths, and flow velocities and is recommended by the staff (NRC 1990). Based on a review of the licensee's computations, the staff concludes that the estimates of flow velocity and depth of flow are acceptable.

4.4.4 Moab Wash

There is a potential for the migration of the main channel of Moab Wash toward the tailings pile. The NRC staff reviewed information and analyses provided by the licensee related to channel migration and conducted independent field investigations in the Moab Wash channel and overbank area. Based on available information, the staff is concerned that during the 1000-year design life, Moab Wash may vary its location periodically and unpredictably, and the licensee has provided no basis to conclude that Moab Wash cannot move to a location adjacent to the reclaimed tailings impoundment. To prevent erosion into the tailings embankment, the licensee proposes to provide a large rock toe/apron along the toe of the embankment adjacent to Moab Wash.

Assuming migration of the channel to the toe of the pile, the licensee estimated water surface elevations and flow velocities using HEC-2. The staff reviewed the HEC-2 output files that were provided by the licensee. These files provided information regarding maximum water surface elevations and velocities and included both subcritical and supercritical flow profiles for Moab Wash. Since the supercritical profile resulted in the highest velocities, this profile was used by the licensee to estimate the depth of scour and the configuration of the buried rock wall. Based on staff review of both the supercritical profile and the subcritical profile, the staff concludes that the profiles and velocities were acceptably derived.

In developing the profiles, the licensee used various conservative assumptions regarding the location and configuration of Moab Wash. In addition to the technical bases established by the calculations associated with PMF flows, there are several qualitative reasons for the staff to conclude that the design is acceptable.

First, it is not likely that the channel will migrate all the way to the toe of the pile. A positive slope of about one percent will be maintained from the toe of the embankment toward the main low-flow channel. A large amount of soil will need to be eroded before complete channel migration or avulsion occurs.

Second, the main channel of Moab Wash was assumed to have the same elevation in a migrated condition as its design condition. It is more likely that the channel will have a higher elevation, since it will be eroding into a mass of natural stream deposits in the overbank area that are at a higher elevation. The licensee's estimates of scour depth (See Section 4.5.1.2.2) are therefore conservative, since the migrated channel invert is assumed to be the same as the design condition.

Third, velocities were calculated assuming that the channel retained the same configuration following migration. Such an assumption is conservative, since the eroded channel is likely to be less uniform and have a higher Manning's 'n' value, resulting in a decrease in velocities.

Fourth, the proposed location of Moab Wash is roughly equivalent to the location of the channel prior to initial construction of the Atlas facility. The existing (relocated) channel of Moab Wash adjacent to the tailings pile was realigned to allow for construction of the mill buildings. Based on review of the information provided by the licensee, the channel is more likely to remain in its undisturbed location, rather than migrate.

Fifth, this area is an aggrading alluvial fan area (Mussetter and Harvey, 1994), and deposition along Moab Wash will continue to occur. Such increases in elevation will increase the conservatisms associated with scour depth and the bottom elevation of the buried riprap wall.

4.4.5 Colorado River

The licensee provided detailed information and analyses (Mussetter and Harvey, 1994) and used the HEC-2 computer program to evaluate the hydraulic characteristics of the Colorado River in the immediate vicinity of the reclaimed pile. The study area extended from the Portal area (downstream of the pile) to a location upstream of the U. S. Highway 191 bridge (upstream of the pile).

For these water surface profile analyses, the licensee surveyed fourteen cross sections of the river. The surveyed sections were tied to the State Plane Coordinate System and were extended into the overbank area using data from available topographic maps. Construction drawings for the Route 191 highway bridge were obtained from the Utah Department of Highways and Transportation.

The licensee first calibrated the HEC-2 model by comparing model results to observed high water marks for known discharges. This calibration was done to verify that input parameters to the model, such as Manning's 'n' value, were appropriate. Comparisons were performed for discharges ranging from 4000 cfs to 48,900 cfs. In addition, the predicted water surface elevation at the toe of the tailings pile for a discharge of 70,300 (peak flow rate of the 1984 flood) was consistent with local observations in 1984 that the flood reached the toe of the tailings pile.

Following calibration of the HEC-2 model, the licensee analyzed water surface profiles and velocities for various discharges up to the magnitude of the PMF. A summary of the analyses is provided in the table below for cross section 5, which is located near the upstream end of the pile:

Event	Flow Rate (cfs)	Water Surface Elevation (ft msl)	Channel Velocity (ft/sec)	Overbank Velocity (ft/sec)
Calibration	4000	3952.0	2.51	---
Calibration	20000	3959.1	4.08	---
1993 Flood	48900	3964.7	6.03	0.17
1984 Flood	70300	3967.6	6.91	0.56
500-yr Flood	123500	3975.8	5.75	0.98
PMF (Atlas)	178000	3983.1	4.61	0.90
PMF (NRC)	300000	3996.7	3.14	0.71

For explanation purposes, the event is a brief description of the flow that was analyzed; the flow rate is the flood discharge in cubic feet per second (cfs) for that event; the water surface elevation is the water surface elevation in feet above mean sea level (ft msl) at cross section 5; the channel velocity is the average velocity in feet per second (ft/sec) in the main channel of the Colorado River at cross section 5; and the overbank velocity is the average velocity in ft/sec in the overbank area adjacent to the pile at cross section 5 and is used to conservatively represent the maximum velocity that will occur on the pile side slopes. Cross section 5 was chosen because the computed channel velocities are higher than those at cross section 6.

The HEC-2 analysis performed by the licensee indicated that a peak discharge of 300,000 cfs in the Colorado River would result in an elevation of about 3996.7 ft msl. The maximum flow velocity occurred at a discharge of about 70,000 cfs and was about 7 ft/sec. The toe of the tailings impoundment is at an elevation of about 3968 feet. Therefore, a PMF discharge of 300,000 cfs would result in a depth of water of about 29 feet against the tailings impoundment. The maximum flow velocity (in the overbank against the side slope) of about one foot per second is well below the velocity considered to cause erosion to the rock armored impoundment side slopes. The licensee concluded that the riprap proposed for the impoundment side slopes is adequate for resisting extreme floods in the Colorado River (See Section 4.5, below).

To independently verify the licensee's conclusions, a sensitivity study was performed assuming a larger flood discharge in the Colorado River. This analysis indicated that even a discharge of 600,000 cfs (the approximate PMF at Hoover Dam) would not result in erosive flow velocities against the tailings impoundment. Such a discharge would have a maximum flow velocity against the reclaimed tailings of about 1.6 feet per second (fps), even though the toe of the pile would be inundated by about 50 feet of water.

Such low flow velocities result from a narrow gorge 2 miles downstream of the mill site called the Portal. This channel constriction has limited flood carrying capacity; consequently, during an extreme flood event, floodwaters will pond in the wide river channel and overbank areas upstream of the Portal. This situation is analogous to that of a dam which ponds water in the upper end of its reservoir due to the limited capacity of the outlet. For example, during routine flows, a river channel flowing into the reservoir may have flow velocities in excess of 10 ft/sec; however, if reservoir ponding occurs to inundate the channel, the velocity could be less than one ft/sec in the same channel for a larger flow rate. This is essentially what happens on the Colorado River near the Atlas site during large floods. The river channel at the Portal is capable of discharging only a relatively low (compared to areas upstream) flow, and when that flow rate is exceeded, ponding occurs, reducing velocities upstream of the Portal.

In spite of the low velocities that are produced during the occurrence of major flood flows, the staff is concerned that there is a potential for the Colorado River to migrate and possibly reach the toe of the reclaimed tailings disposal area. These concerns are based on staff observations and review of licensee analyses which indicate that erosion will occur during lesser flood events and this erosion is currently on-going in the immediate site area. Further, the Colorado river may have once been located north of the pile, and there is no assurance that it could not migrate northward to this location again. The licensee has indicated that the potential for migration is very low and that there are several bases supporting this low probability. The staff requested that Atlas provide quantitative evidence to support this conclusion; however, Atlas was not able to do so. Therefore, Atlas intends to provide a large rock apron at the toe of the disposal cell to protect the pile from erosion. The apron will be located on the southeastern side of the pile and will be designed to collapse into the channel, if migration occurs. The staff concludes that providing such a design measure is appropriate, since quantitative proof of channel stability cannot be provided.

However, the staff reviewed the licensee's qualitative information and generally concludes that the potential for migration is very low during a 200-1000 year period. Several site-specific factors need to be considered.

First, channel migration is normally the result of the meandering of a freely-adjustable stream. The ability of the Colorado River to meander across the Moab Valley is restricted by bedrock controls upstream at the valley entrance and downstream at the Portal.

Second, the rate of bank retreat is dependent upon the forces exerted and the resistance of the bank material to erosion. The maximum velocity of the river

is about 7 ft/sec, which is generally not extremely erosive. Further, the overbank area between the river and the disposal area is heavily vegetated with grass, weeds, and tamarisks. Such heavy vegetation provides a considerable amount of erosional stability for both erosion and bank sloughing.

Third, the presence of mid-channel bars would tend to indicate that the river is probably aggrading more than it is eroding. This indicates that velocities in the area are low, tending to cause deposition rather than erosion.

Fourth, a considerable amount of aggradation caused by sediments from Moab Wash and Courthouse Wash appears to be occurring. There is some evidence to suggest that 2.5 feet of aggradation have occurred over the last 20 years (Mussetter and Harvey, 1994).

Fifth, aerial photographs indicate that lateral accretion has occurred along the river bank downstream of the site. Photographs taken between 1960 and 1985 indicate that some accretion has occurred in this area.

In summary, the staff concludes that it is unlikely that the river will migrate as far as the tailings pile within the next 200-1000 years. However, because quantitative proof of bank stability was not provided, it is prudent to design the pile for such an occurrence. The licensee intends to provide an erosion protection apron for the pile and this measure is considered by the staff to be a conservative method for addressing Colorado River erosion concerns. A detailed discussion of the design of the apron may be found in Section 4.5.1.2.3.

4.5 Erosion Protection

The ability of a riprap layer to resist the velocities and shear forces associated with surface flows over the layer is related to the size and weight of the stones which make up the layer. Typically, riprap layers consist of a mass of well-graded rocks which vary in size. Because of the variation in rock sizes, design criteria are generally expressed in terms of the median stone size, D_{50}, where the numerical subscript denotes the percentage of the graded material that contains stones of less weight. For example, a rock layer with a D_{50} of 4 inches could contain rocks ranging in size from 0.75 inches to 6 inches; however, at least 50% of the weight of the layer will be provided by rocks that are 4 inches or larger.

Depending on the rock source, variations occur in the sizes of rock available for production and placement on the reclaimed pile. It is necessary to ensure that the variation in rock sizes is not extreme, and design criteria for developing acceptable gradations are provided by various sources (COE 1971; DOI 1982).

4.5.1 Sizing of Erosion Protection

Riprap layers of various sizes and thicknesses are proposed for use at the site. The design of each layer is dependent on its location and purpose. The licensee proposes to use several different sizes and layer thicknesses,

depending on the location and erosive forces that could occur. To reduce the number of gradations that need to be produced, the licensee will place larger rock in some areas than is required. For example, rock to be used on the upper portion of the top slope has a average size of 1.3 inches. However, in the extreme upper portion of this upper slope, rock requirements are much less than 1.3 inches. For ease of construction and to minimize the number of gradations, the licensee has purposely overdesigned several areas of the reclaimed surfaces. The following table summarizes the riprap to be used at the Atlas site.

Location/Feature	D50 (inches)	Layer Thickness (inches)
Upper Top Slope	1.3	4
Lower Top Slope	3.0	6
Side Slope (3V:10H)	4.4	9
Moab Wash Buried Rock Wall	4.4	9
Collection Ditches	4.4	9
Upper Impoundment Dr. Channel	4.4	9
Moab Wash Buried Rock Wall	9.0	13.5
Southwest Drainage Channel	9.0	13.5
Apron along Colorado River	11.2	30
Southwest Drainage Channel	11.2	17
Southwest Drainage Channel	17.4	26
Lower Impoundment Dr. Channel	17.4	26
Lower Southwest Dr. Channel	27.6	52

Discussion of the design of each of these features is provided in the sections that follow below.

For ease of construction, the licensee intends to minimize the number of different rock sizes and gradations to be produced at the quarries that are eventually selected. It should be emphasized that the riprap sizes in the above table and in the following sections are based on recent information that was informally transmitted by the licensee to the NRC staff. At the present time, some of this information conflicts with information presented in tables and calculations previously submitted. The licensee intends to modify the rock sizes, layer thicknesses, and gradations in formal submittals to be provided at a later date. Until those submittals are provided, the staff cannot conclude that the overall riprap design is adequate.

Staff review has focused principally on the D_{50} sizes informally proposed by the licensee, and this review has been done to determine that the D_{50} size is adequate for each of the different locations in the design. However, details

of layer thicknesses and gradations have not been provided. Final approval of the layer thicknesses and gradations can be given only after that information is provided for staff review. Therefore, the overall riprap design is considered an **OPEN ISSUE**, pending formal submittal of the riprap design.

4.5.1.1 Top and Side Slopes

The riprap on the top slope has been sized to withstand the erosive velocities resulting from an on-cell PMP, as discussed in previous sections. The licensee proposes to use a 4-inch rock layer with a minimum D_{50} rock size of 1.3 inches at the upper portion of the cell. For the lower portion of the top slope, a 6-inch layer with a minimum D_{50} of 3 inches will be used. The Safety Factors Method was used to determine the rock sizes. Based on staff review of the calculations, we conclude that the design is acceptable.

The riprap for the side slopes is also designed for an occurrence of the local PMP. The licensee proposes to use a 9-inch layer of rock with a minimum D_{50} of 4.4 inches. The rock layer will be placed on a 6-inch bedding layer. Stephenson's Method was used to determine the required rock size. Conservative values were used for the specific gravity of the rock, the rock angle of internal friction, and porosity. Based on staff review of the licensee's analyses and the acceptability of using design methods recommended by the NRC staff, as discussed in Section 4.4 of this report, the staff concludes that the proposed rock size for the side slope is adequate.

The riprap proposed for the side slopes of the tailings embankment could be subjected to shear stresses from the PMF in the Colorado River. In addition, the tailings impoundment is located on the outside bend of the Colorado River where the river turns from a westerly to a southerly direction. Because the potential for erosion is greater at the outside bend of a channel, an analysis was performed using the COE procedures (COE 1994) to determine if the riprap proposed for the embankment side slopes was of sufficient size to resist the erosion potential at the outside river bend. Based on the use of COE procedures, the staff concludes that the estimated flow velocity of about one ft/sec is well below the velocity that the riprap on the embankment side slopes can withstand. On this basis, it was concluded that a PMF in the Colorado River will not adversely affect the stability of the reclaimed tailings pile.

As discussed in Section 4.4.5, there is a potential for the Colorado River to migrate towards the tailings pile. For conservatism, the staff assumed that the river channel will migrate to a location immediately adjacent to the embankment side slope and that the peak channel flow velocity of about 7 ft/sec will occur. The staff considers this scenario to be extremely unlikely, even in a 1000-year design lifetime. However, based on review of the velocity adjacent to the side slope, the proposed riprap size of 4.4 inches is also capable of resisting this peak channel velocity. As discussed in Section 4.5.1.2.3, the controlling hydraulic design force results from overland flows directly down the pile side slope.

4.5.1.2 Apron/Toe

As previously discussed, the design of the apron/toe area must be capable of withstanding various phenomena. The riprap design is dependent on the specific location of the toe, and erosion protection needs to be provided against (1) overland flows down the side slope onto the toe, (2) Moab Wash, and (3) the Colorado River.

4.5.1.2.1 Overland Flows

In those areas where the embankment side slopes or toes are not affected by the Colorado River or by Moab Wash, the licensee has designed the side slopes to simply transition to natural ground. The riprap on the pile side slope will be extended and the toe will consist of rock extended 3 feet below the surface of the ground. This depth is greater than the estimated scour of 0.92 foot, which was estimated using accepted procedures (DOT, 1975). This method for estimating scour depth is recommended in the STP on Erosion Protection (NRC 1990). Based on review of the calculations provided by the licensee, the staff concludes that this aspect of the toe design is acceptable.

4.5.1.2.2 Moab Wash

As discussed in Section 4.4.4, above, the licensee provided designs and analyses of the riprap to be placed along the sides and toe of the pile, assuming that the main channel of Moab Wash had migrated to a new location immediately adjacent to the toe of the side slope embankment. The design included consideration of the: (1) potential future location of the channel; (2) estimated depth of scour; and (3) PMF water surface elevations.

To determine the areal extent of the apron/toe erosion protection, it was necessary for the licensee to analyze the hydraulic characteristics, assuming migration of the main channel of Moab Wash. The licensee developed water surface profiles and velocity estimates for such a channel configuration (See Section 4.4.4). Based on the velocity estimates and an evaluation of the potential for scour, erosion, and deposition, the licensee will construct a buried riprap wall along the toe of the pile, with the rock extending downward to the expected depth of scour. The buried wall will be constructed from the mouth of the lower impoundment drainage channel eastward to the point where the northeast debris pit begins. From there, the buried wall will extend southeastward to a point where the wall joins the rock apron that protects the pile from Colorado River migration (See Section 4.5.1.2.3).

The licensee concluded that the potential for channel migration toward the pile was greatest along the north side of the pile, where Moab Wash could be expected to meander and encroach upon the toe of the slope. In this area, the cross-sectional flow area is smallest, and velocities will be highest. Along the east side of the pile, beginning at the northeast debris pit, the flow area becomes much larger and the flow velocities are much lower. Therefore, the potential for channel migration in this area is lower.

The depth of scour was estimated by the licensee using four different methods, as recommended by Pemberton and Lara (1984). Using the field measurement method, the Regime Equation method, the mean velocity method, and limiting scour control method, the licensee estimated the average scour depth to be

about 7-8 feet at most locations along the northern portion of the disposal cell. Along the northeastern portion of the cell in the area of the debris pit, a scour depth averaging about 3.6 feet was estimated. Based on a review of computations provided by the licensee, the staff concludes that the estimates are acceptable.

The riprap to be provided in the toe area was estimated by the licensee using the Corps of Engineers allowable shear stress method (COE 1994). This method is appropriate when flow depths are larger than the rock size. The staff reviewed computations provided by the licensee and independently estimated the rock size using methods discussed in NUREG/CR-4651 (Abt, et al., 1987). Based on this review, the staff concludes that the proposed D_{50} rock sizes of 9 inches and 4.4 inches are acceptable for the northern and northeastern toe areas, respectively.

4.5.1.2.3 Colorado River

As discussed in Section 4.4.5, above, the licensee provided designs and analyses for the riprap to be placed along the sides and toe of the pile, assuming that the channel of the Colorado River had migrated to a new location immediately adjacent to the toe of the side slope embankment. The revised design included consideration of the: (1) assumed future location of the channel; (2) estimated depth of scour; and (3) required volume and size of the riprap.

To determine the areal extent of the apron/toe erosion protection, the licensee simply assumed that the main channel of the river would erode toward the pile and would ultimately exist immediately adjacent to the toe of the pile at all points along the southeastern side. The staff considers this to be an unlikely situation and a conservative assumption. Based on a geomorphic evaluation (Mussetter and Harvey, 1994) of the potential for scour, erosion, and deposition, the licensee will construct a large rock apron along the toe of the pile. The apron will be provided from the mouth of the southwest drainage channel northeastward to the point where it joins the Moab Wash toe protection in the area of the debris pit.

To estimate the depth of scour associated with migration of the river, the licensee conservatively assumed that the river channel would retain essentially the same elevations and configuration in its migrated state as in its current state. The current minimum river bottom elevation was assumed to be the maximum depth of scour. This assumption resulted in an estimated scour depth of about 21 feet. Based a review of the information provided, the staff concludes that the assumptions are acceptable.

To provide adequate erosion protection and to prevent erosion of the embankment side slope, the licensee will provide a large essentially horizontal, rock apron, designed to collapse onto the side slope of the migrated river channel. The rock volume will be sufficient to cover the channel bank and to prevent further erosion of the river bank and the pile side slope. The riprap to be provided for the rock apron was estimated by the licensee using methods developed by the COE (COE 1994). The staff reviewed computations provided by the licensee. Based on this review, the staff

concludes that the proposed apron length and thickness will provide an adequate volume of rock to protect the side slope from further migration of the Colorado River.

The size of the riprap to be placed in the apron is not controlled by flow velocities in the Colorado River. As discussed above, the maximum flow velocity of the river (using the extremely conservative assumption that the main channel, rather than the overbank, is adjacent to the pile side slope) is about 7 ft/sec, produced by a flow of about 70,000 cfs. If this were the controlling case, the side slope rock size of 4.4 inches would be more than adequate to prevent further erosion. Actually, the size of the apron rock is controlled by overland flows directly down the side slope. The licensee assumed that when the rock collapses into the scoured area, it will collapse onto the river bank in a configuration where the side slope is 1V on 2H. Flows directly down a 1V on 2H slope will require a rock size larger than 4.4 inches, which would be adequate for the 3V on 10H side slope. To provide the required protection, the licensee used the Stephenson Method to determine that the riprap apron will need an average rock size of 11.2 inches. Based on review of the computations provided by the licensee, the staff concludes that this rock size is acceptable.

4.5.1.3 Collection Ditches and Drainage Channels

Median rock diameters (D_{50}) for the collection ditches and drainage channels were estimated by the licensee using either the Corps of Engineers' Shear Stress Method (COE 1994) or the Safety Factors Method (Stevens et al., 1976). The COE method was used in cases where channel flow depths are large, relative to the median rock diameter. For shallow channels, the Safety Factors Method was used. The methods used by the licensee for designing erosion protection are those recommended in the STP on Erosion Protection (NRC 1990), and are therefore acceptable.

To verify the licensee's riprap design for the collection ditches and channels, independent analyses were performed using methods developed by NRC contractors (Abt, et al., 1987), the Safety Factors Method, and the Corps of Engineers' Shear Stress Method. These independent analyses indicated that the D_{50} values proposed by the licensee are adequate. Therefore, the staff concludes that the riprap sizes proposed by the licensee are acceptable.

4.5.1.3.1 Ditch Outlets

The licensee proposes to construct heavily-armored rock sections at the outlets of both the Southwest Runoff Drainage Channel (SWDC) and the Lower Impoundment Drainage Channel (LIDC). Their purpose is to protect the outlets of these channels from headcutting that may result from scour and may propagate upstream, potentially impinging on tailings. The depth of the proposed rock protection is equal to the expected depth of scour, which was estimated by the licensee to be approximately 8 feet. The outlet sections were assumed to collapse due to either: 1) gully headward erosion over a long period of time, or 2) the PMF flows in the ditches. In order to reduce the rock size required at the outlets, the licensee proposes to construct outlet slopes of 1V on 9H. In this design case, the scoured configuration is pre-

constructed, rather than assumed to have collapsed randomly into a steeper configuration requiring much larger rock.

The D_{50} sizes of the rock in the outlet sections are proposed by the licensee to be 17.4 inches for both the SWDC (for a discharge of 1723 cfs and bottom width of 100 feet) and the LIDC (for a discharge of 1640 cfs and bottom width of 100 feet). This size is larger than the required size of about 16 inches computed by the licensee using the Stephenson Method. Based on a review of the calculations by the staff, the designs of the outlet sections are considered to be acceptable.

The licensee does not propose to provide outlet protection at the outlet of Moab Wash because the elevation of the outlet is controlled by the Colorado River. It is highly unlikely that the base level of the Colorado River will change during the performance period (Mussetter and Harvey, 1994). Therefore, the outlet of Moab Wash should remain fairly stable. The NRC staff agrees that outlet protection is not required for Moab Wash.

4.5.1.3.2 Sediment Considerations

In general, sediment deposition can be a problem in diversion ditches when the slope of the diversion ditch is less than the slope of the natural ground where flows enter the ditch. It is usually necessary to provide sufficient slope and capacity in the diversion ditch to flush or store any sediments which will enter the ditch. Concentrated flows and high velocities could transport large quantities of sediment, and the size of the particles transported by the natural gully may be larger than the man-made diversion ditch can effectively flush out.

For this site, a considerable amount of sediment from the upland drainage area can be expected to enter the Southwest Diversion Channel (SWDC), for the following reasons:

1. The upland drainage area has an extremely steep slope in the vicinity of the ditch, whereas the diversion ditch itself has been designed with a relatively flat slope in the reaches adjacent to the tailings embankment. Flow velocities in the ditches may not be as high as those occurring on the natural ground. Therefore, sediment, cobbles, and boulders may be transported to the ditch and may not be easily be flushed out by the lower velocities in the ditch.

2. The potential for gully development (and resulting high flow velocities) in the upland drainage area and subsequent transport of material into the diversion ditch is high. Gullies and areas of flow concentration are evident upstream of the diversion ditch, based on review of topographic maps of the area and a staff site visit to the area. Flows moving towards the diversion ditch will tend to concentrate in these gullies, increasing the potential for gully incision and transport of sediment.

To document the acceptability of the ditch design, the licensee demonstrated that the ditch will be capable of discharging the design flows, even if

blockage occurs. The licensee assumed that sediment, debris, and large rocks would be deposited in the SWDC. The licensee determined that this channel would have adequate flow capacity, even if a significant amount of blockage (50%) occurred. The licensee performed analyses using HEC-2 and determined the effects of blockage on flow velocities and water surface profiles. The licensee determined that the blockage would raise PMF water surface elevations in the channel. The licensee proposes to vertically extend the required riprap to the increased elevations. Also, the blockage will increase the velocities, and the licensee will provide riprap of adequate size to resist those increased velocities. The proposed riprap varies in size from 9 inches in the upper reaches of the channel to 17 inches in the lower portions of the channel and was sized using the COE design methods (COE 1994) and the Safety Factors Method (Stevens et al., 1976).

Further, the licensee determined that the increased velocities will increase the depth of scour along the side slope, and therefore proposes to extend the side slope riprap vertically downward to the expected scour depth. The scour depth was determined using procedures discussed by Pemberton and Lara (1984); the acceptability of these scour analyses is discussed in Section 4.5.1.2.2.

Based on a review of the calculations provided, including the water surface profiles and riprap sizing techniques, the staff concludes that the SWDC will effectively accommodate a large amount of rock and debris entering the channel. The staff further concludes that the channel will convey PMF flows in a manner that will not affect the stability of the pile.

At the present time, it is not clear if a severe landslide potential exists in the site area. This issue is currently being evaluated by the staff and is further discussed in Section 2.4. If a landslide potential exists, design changes may be needed to the SWDC to accommodate the expected sediment input into the channel. This is an **OPEN ISSUE**.

4.5.2 Riprap Gradations

The various estimated D_{50} values were used as the basis for the design of well graded mixtures of rock to resist the shear forces of the PMF peak discharge. Riprap gradations and layer thicknesses were developed by the licensee using the criteria outlined in Surface Mining Water Diversions Design Manual (Simons and Li, 1982). To verify the adequacy of the licensee's proposed riprap gradations, independent spot checks were made by the staff using design methods presented in NUREG/CR-4620 (Nelson, et al, 1986). These checks indicated that the gradations proposed by the licensee are acceptable.

The licensee estimated many riprap sizes for the various applications. However, to reduce the number of different riprap sizes and gradations, the licensee elected to use larger rock than required in many areas. Thus, additional conservatisms are added to the design in those areas where larger rock than required is used.

4.5.3 Rock Durability

NRC regulations require that control of residual radioactive materials be

effective for up to 1000 years, to the extent reasonably achievable, and, in any case, for at least 200 years. The previous sections of this TER examined the ability of the erosion protection to withstand flooding events reasonably expected to occur in 1000 years. In this section, rock durability is considered to determine if there is reasonable assurance that the rock itself will survive and remain effective for 1000 years.

Rock durability is defined as the ability of a material to withstand the forces of weathering. Factors that affect rock durability are 1) chemical reactions with water, 2) saturation time, 3) temperature of the water, 4) scour by sediments, 5) windblown scour, 6) wetting and drying, and 7) freezing and thawing.

To assure that the rock used for erosion protection remains effective for up to 1000 years as required by Criterion 6 of 10 CFR Part 40, Appendix A, potential rock sources must be tested and evaluated to identify acceptable sources of riprap. A procedure for determining the acceptability of a rock source is presented in Appendix D of the STP on Erosion Protection (NRC 1990). The procedure discussed in the STP includes the following steps:

Step 1. Test results from representative samples are scored on a scale of 0 to 10. Results of 8 to 10 are considered "good"; results of 5 to 8 are considered "fair"; and results of 0 to 5 are considered "poor."

Step 2. The score is multiplied by a weighting factor. The effect of the weighting factor is to focus the scoring on those tests that are the most applicable for the particular rock type being tested.

Step 3. The weighted scores are totaled, divided by the maximum possible score, and multiplied by 100 to determine the rating.

Step 4. The rock quality scores are then compared to the criteria which determines its acceptability, as defined in the NRC scoring procedures.

After these tests are conducted, a rock quality score is determined. Different minimum scores, depending on the location where the rock will be placed, are recommended in the STP. Rock scoring 80 percent or greater indicates high quality rock that can be used for any application. Rock scores between 65 and 80 percent indicate less durable rock that can also be used for most applications, provided that the riprap is appropriately oversized. Rock scoring less than 65 percent cannot be used for critical areas such as diversion ditches or poorly drained toes and aprons. Rock scoring between 50 and 65 percent can be used in non-critical areas such as well drained tailings pile tops and side slopes provided it is oversized as recommended in the STP on Erosion Protection (NRC 1990). Rock scoring less than 50 percent is not recommended for use in any application.

In general, rock durability testing is performed using standard test procedures, such as those developed by the American Society for Testing and Materials (ASTM). The ASTM publishes and updates an Annual Book of ASTM Standards (ASTM, 1995), and rock durability testing is usually performed using

these standardized test methods.

Initially, the licensee identified seven potential rock sources in the proximity of the Atlas Mill. Four of the sources were rounded igneous alluvial rock, two sources were sedimentary rock, and one source was an igneous outcrop. Petrographic analyses using ASTM C 295 were performed by the licensee on samples from the sedimentary sources and on samples of alluvial rock. These analyses indicated that some of the sources could be considered for further physical testing. Rock samples were then tested for Bulk Specific Gravity and Absorption (ASTM C 127), Sodium Sulfate Soundness (ASTM C 88), Los Angeles Abrasion (ASTM C 131 or C 535) and Tensile Strength. The results of these tests were then evaluated using procedures recommended in the STP on Erosion Protection (NRC 1990). This evaluation indicated to the licensee that the sedimentary rock weathered very rapidly, scoring only 37 and 45 percent. These rock sources are not useable since they scored less than 50 percent. Two samples of the igneous alluvial rock scored 65 and 68 percent. This rock can be used for any application if it is oversized as recommended in the STP on Erosion Protection (NRC 1990). Use of the alluvial rock source may be limited, because the maximum D_{50} is probably less than 3 inches. The sample from the igneous rock outcrop was the most durable, having scored 78 percent. Atlas reserves the right to either use the tested rock or an alternate source. Regardless of the rock source used, the licensee has committed to meet the durability and oversizing recommendations of the STP on Erosion Protection.

Based on a review of the rock durability analysis provided by Atlas, and considering the commitment to comply with the STP on Erosion Protection (NRC 1990), it was concluded that acceptable rock will be used for erosion protection.

4.5.4 Testing and Inspection of Erosion Protection

The staff reviewed and evaluated the testing, inspection, and quality control procedures proposed by the licensee for the erosion protection materials and design features. The review included evaluations of programs for durability testing, gradation testing, rock placement, and verification of rock layer thicknesses.

4.5.4.1 Durability Testing

The licensee's proposed rock durability testing will include the following tests, shown with their ASTM designation:

1. Bulk Specific Gravity - ASTM C 127
2. Absorption - ASTM C 127
3. Sodium Sulfate Soundness - ASTM C 88
4. L.A. Abrasion at 100 cycles - ASTM C 131 or ASTM C 535

Durability test results will be used by the licensee to determine a rock durability rating in accordance with Table D-1 of the STP on Erosion Protection (NRC 1990). The licensee proposes that the following criteria will be used to determine acceptable uses of rock, based on its durability rating:

1. Rock having a durability rating of greater than or equal to 80 may be used as riprap or filter material.

2. Rock having a durability rating of less than 80 and greater than or equal to 65 may be placed in surface water control ditches, and used as riprap or filter material only after being oversized in accordance with the STP.

3. Rock having a durability rating of less than 80 and greater than or equal to 50 may be used on the top or side slopes, only after being oversized in accordance with the STP.

4. Rock having a durability rating of less than 65 may not be used for riprap or filter material in a drainage channel. Rock having a durability rating of less than 50 may not be used for any application.

5. In addition to oversizing the rock according to the durability ratings, an additional oversizing factor of 20 percent will be added if rounded alluvial rock is used.

The licensee proposes that a minimum of one initial test series will be performed prior to using rock for riprap or filter material. Additional test series will be performed when approximately one-third and two-thirds of the total volume of each type of riprap or filter material have been delivered. When the total volume of any type of riprap or filter material exceeds 30,000 cubic yards, the licensee will conduct an additional test series for each additional 10,000 cubic yards delivered. The licensee also committed to performing additional tests when the rock characteristics (i.e., color or texture) in the rock borrow source vary significantly from the rock that was previously tested.

Based on a review of the proposed procedures, the staff concludes that the durability testing program will ensure that rock of acceptable quality is provided. The testing program is equivalent to several which were approved by the staff and have been implemented at other reclaimed sites during construction.

4.5.4.2 Gradation Testing

The licensee proposes that riprap, rock mulch, and the filter material gradations will be verified during reclamation using the following procedures:

1. Filter gradations will be tested using ASTM C 136, Standard Method for Sieve Analysis of Fine and Coarse Aggregates, or ASTM D 422, Standard Test Method for Particle-Size Analysis of Soils, as appropriate.

2. For riprap having a maximum nominal diameter (D_{100}) of less than or equal to 6 inches, ASTM C 136, Standard Method for Sieve Analysis of Fine and Coarse Aggregates, will be used to verify that gradations comply with the specifications.

3. Gradation testing will be performed at the same frequency as rock

durability testing.

Based on a review of the proposed procedures, the staff concludes that the gradation testing program will ensure that rock layers with acceptable gradations are provided. The testing program is equivalent to several which were approved by the staff and have been implemented at other reclaimed sites during construction.

4.5.4.3 Riprap Placement

The licensee proposes a placement program where: (1) riprap will be placed to the depths and grades shown on the drawings; (2) riprap will be placed in a manner to ensure that the larger rock fragments are uniformly distributed and the smaller rock fragments serve to fill the void spaces between the larger rock fragments, so that a densely packed, uniform layer of riprap of the specified thickness will result; (3) hand placing will be used, as necessary, to ensure proper results; and (4) material that does not meet these specifications will be either reworked or removed and replaced as necessary.

Based on a review of the licensee's proposal, the staff concludes that the procedures will ensure acceptable placement. The placement procedures are equivalent to several which were approved by the staff and have been implemented at other reclaimed sites during construction.

4.5.4.4 Rock Layer Thickness Testing

The licensee proposes that the thickness of the rock layers will be verified by establishing a 200-foot by 200-foot grid over the tailings impoundment and using specific procedures for measuring and recording depths. Visual examinations will also be conducted to verify the uniformity of depths.

Based on a review of the information provided, the staff concludes that the proposed testing program is acceptable. Combined with the rock placement procedures discussed in Section 4.5.4.3, above, the program conforms to other previously-approved programs that have been implemented at other Title I and Title II sites.

4.6 Upstream Dam Failures

There are no impoundments near the site whose failure could potentially affect the site.

4.7 Conclusions

Based on review of the information submitted by the licensee and on independent calculations, the NRC staff concludes that the licensee has identified the appropriate floods for the design of erosion protection features at the site. The staff further concludes that water surface profiles and channel velocities were appropriately derived and are acceptable as a basis for the design of erosion protection features. Based on the most recent informal licensee information, the erosion protection design appears to be adequate to provide reasonable assurance of protection for 1000 years, as

required in Criterion 6 of 10 CFR Part 40, Appendix A. However, recent information related to rock sizes and layer thicknesses conflicts with information presented in tables and calculations previously submitted. The staff understands that the licensee intends to modify the rock sizes, layer thicknesses, and gradations in formal submittals to be provided at a later date. Until those submittals are provided, the staff cannot conclude that the overall riprap design is adequate. Furthermore, it is not clear if a severe landslide potential exists in the site area. This issue is currently being evaluated in the staff's geology review. If a landslide potential exists, design changes may be needed to the Southwest Runoff Diversion Channel to accommodate the expected sediment input into the channel.

4.0 REFERENCES

Abt, S.R., et al., 1987, Development of Riprap Design Criteria by Riprap Testing In Flumes, Phase I: U.S. Nuclear Regulatory Commission, NUREG/CR-4651.

ACE (U.S. Army Corps of Engineers), 1970, Hydraulic Design of Flood Control Channels: EM1110-2-1601, revised 1994.

ACE (U. S. Army Corps of Engineers), 1971, Additional Guidance for Riprap Channel Protection: ETL 1110-2-120.

ACE (U. S. Army Corps of Engineers), 1991 update, "HEC-2 Water Surface Profiles," Hydrologic Engineering Center, Davis, CA.

ACE (U. S. Army Corps of Engineers), 1988, HEC-1 Flood Hydrograph Package, Hydrologic Engineering Center, Davis, CA.

Atlas Corporation, "Reclamation Plan Uranium Mill and Tailings Disposal Area," January, 1994.

Atlas Corporation, "Reclamation Plan Uranium Mill and Tailings Disposal Area," March, 1995.

Chow, V.T., 1959, Open Channel Hydraulics: McGraw-Hill, New York.
Davis, C.V., and Sorensen, K.E., eds., 1969, Handbook of Applied Hydraulics: Third Edition, McGraw Hill Book Co., New York.

Chow, V. T., 1964, Handbook of Applied Hydrology, McGraw-Hill Book Co. New York.

Crippen, J. R., and C.D. Bue, Maximum Floodflows in the Conterminous United States, 1977, USGS Water Supply Paper 1887, GPO, Washington DC.

DOT (U.S. Department of Transportation), 1975, Hydraulic Design of Energy Dissipators for Culverts and Channels: Hydraulic Engineering Circular No. 14, December 1975.

Enzel, Y., et al., Paleoflood Evidence for a Natural Upper Bound to Flood Magnitudes in the Colorado River Basin, Water Resources Research, Vol. 29, No.7.

Mussetter, R. A., and M.D. Harvey, 1994, Geomorphic, Hydraulic, and Lateral Migration Characteristics of the Colorado River Moab, Utah, May 1994, Mussetter Engineering, Inc.

Nelson, J. D., et al., 1986, Methodologies for Evaluating Long-Term Stabilization Designs of Uranium Mill Tailings Impoundments, NUREG/CR-4620.

NOAA (National Oceanic and Atmospheric Administration), 1977, Probable Maximum Precipitation Estimates, Colorado River and Great Basin Drainages: U.S. Department of Commerce, Hydrometeorological Report No. 49.

NRC, 1990, Final Staff Technical Position, Design of Erosion Protection Covers for Stabilization of Uranium Mill Tailings Sites: U.S. Nuclear Regulatory Commission, August 1990.

NRC, 1993, Final Standard Review Plan for the Review and Remedial Action of Inactive Mill Tailings Sites under Title I of the Uranium Mill Tailings Radiation Control Act, Revision 1: U.S. Nuclear Regulatory Commission, June 1993.

Pemberton, E. L., and J. M. Lara, 1984, "Computing Degradation and Local Scour," U. S. Bureau of Reclamation, Denver, CO.

Simons, D. B., and R. K. Li, 1982, Surface Mining Diversions Design Manual, Office of Surface Mining, OSM/TR-52/2, United States Department of the Interior, September 1982.

Stephenson, D., 1979, Rockfill in Hydraulic Engineering: Elsevier Scientific Publishing Co., New York.

Stevens, M.A., D. B. Simons, and G. L. Lewis, 1976, Safety Factors for Riprap Protection: American Society of Civil Engineers, Journal of the Hydraulics Division, V. 102, No. HY5.

USBR (U.S. Bureau of Reclamation), 1977, Design of Small Dams: U.S. Department of the Interior.

USBR, 1990, Colorado River Basin, Probable Maximum Floods, Hoover and Glen Canyon Dams, September, 1990.

7.0 APPENDIX A ASSESSMENT

Appendix A to 10 CFR 40 establishes technical, financial, ownership, and long-term site surveillance criteria relating to the siting, operation, decontamination, decommissioning, and reclamation of uranium milling facilities. Each site-specific licensing decision is to be based on the criteria in the appendix, taking into account the public health and safety and the environment. Decisions based on the criteria in the appendix must take into account the risk to the public health and safety and the environment with due consideration to the economic costs involved. Decisions as to the ability of the design to meet "reasonably achievable" criteria must take into consideration the state of technology as well as the economics of improvements in relation to the resulting benefits.

The following Appendix A criteria were considered for the proposed licensing decision to amend Source Material License SUA-917 in accordance with the reclamation plan submittals. Criterion 2, 8, and 11 are not applicable for review and approval of a reclamation plan and were therefore not considered.

Criterion 1

Criterion 1 addresses the general goal of siting and designing facilities to provide for the permanent isolation of tailings and associated contaminates by minimizing disturbance and dispersion by natural forces without the need for ongoing maintenance. The following site features must be considered when evaluating a proposed site:

1. Remoteness from populated areas:

    The Moab Mill is located on the west bank of the Colorado River, 3 road miles northwest of the City of Moab, in Grand County, Utah. There is a private residence adjacent to the restricted area to the northeast. The 1990 census reports a population of 4050 for the city of Moab. This shows a decrease in population from the 1980 census which reported a population of 5333 for Moab. The population of Grand County has also decreased from a population of 8200 in 1980 to 6800 according to the Utah Department of Employment Security. Review of data from the licensee indicates that the population within a 10 km radius of the mill has been declining since 1970. (See Draft Environmental Impact Statement, October 1995.)

    Adjacent lands and waters are used for a variety of activities. State Highway 279 and U.S. Highway 191, both adjacent to the site, are major transportation routes for industry and tourism. Outdoor recreational use of the area is heavy, Arches National Park is located about 2 miles northwest of the site.

    Population projections for these areas are difficult to make. There may be significant population increases in the immediate future due to the development of outdoor recreational facilities and the proximity of National and State parks. It is doubtful, however, that there will be any increase in the immediate proximity of the disposal area. The

Nature Conservatory has purchased the wet-lands between the City of Moab and the Colorado River, prohibiting development in this area. Any development to the east of the disposal area, on the west bank of the Colorado River, would be in the flood plain for Moab Wash and the Colorado River. The licensee will be required to include the entire reconfigured Moab Wash in the final fenced restricted area which will help ensure that there are no future developments in the immediate vicinity of the disposal area.

2. Hydrologic and other natural conditions as they contribute to continued immobilization and isolation of contaminants from ground-water sources:

The reclaimed disposal area will be capped with a cover system which will minimize infiltration. The review of ground-water conditions at the site to assure compliance with 10 CFR 40, Appendix A, is currently being done under other licensing actions. The licensee is currently implementing a corrective action program (CAP) to return ground-water quality to established standards. The CAP was submitted on March 31, 1989, and was fully operational prior to July 1, 1990. The CAP is being revised as a result of information collected since it was initiated.

3. Potential for minimizing erosion, disturbance, and dispersion by natural forces over the long-term:

The potential for wind and water erosion will be minimized by several design features. The tailings will be re-contoured and covered by an erosion protection cover. A drainage system will be constructed to divert precipitation away from the tailings. The tailings cover and diversion channels will be protected from flooding and erosion by engineered rock riprap. The cover and channels have been designed in accordance with the guidance suggested by the staff (NRC 1990). The staff considers that erosion protection which meets that guidance will provide adequate protection against erosion and dispersion by natural forces over the long term.

4. The tailings will be disposed of in a manner that will not require active maintenance to preserve conditions at the site:

The staff considers that the erosion protection will not require active maintenance over the 1000-year design life, for the following reasons: 1) the riprap has been designed to protect the tailings from rainfall and flooding events which have very low probabilities of occurrence over a 1000-year period, resulting in no damage to the layers from those rare events; 2) the rock proposed for the riprap layers will be durable and is not expected to deteriorate significantly over the 1000-year design life; and 3) during construction the rock layers will be placed in accordance with appropriate engineering and testing practices, minimizing the potential for damage, dispersion, and segregation of the rock.

The staff also concludes that the site will not require active maintenance to mitigate the effects of geologic, including seismic,

disturbances. The tailings disposal design has incorporated features to withstand the maximum subsidence and seismic acceleration reasonably expected to occur in the 1000-year design period.

Criterion 3

Criterion 3 sets below-grade disposal as the prime option for tailings disposal.

Relocation of the tailings to another site so that all the contaminated material could be placed below grade is technically feasible; however, the benefits over stabilizing the tailings in place would be negligible. (See Draft Environmental Impact Statement, October 1995.) As the existing site is adequate and it is feasible to design the disposal cell to meet the closure criteria, the cost of disposing the contaminated materials below grade by relocating the disposal area would be much greater than the benefit realized, making relocation economically impracticable.

If below-grade disposal is not practicable, the disposal plan must provide reasonably equivalent isolation of the tailings from natural erosional forces. This is addressed in Criteria 4, 6, and 12.

Criterion 4

Criterion 4 sets specific technical criteria for disposal of tailings.

Criterion 4(a) requires that upstream rainfall catchment areas be minimized to decrease erosion potential and the size of the floods which could erode or wash out sections of the tailings disposal area.

The site is located in an area which is flooded by offsite floods from Moab Wash and the Colorado River. However, as discussed in the Section 4, the site is protected from direct onsite precipitation and flooding by engineered riprap layers for the top and side slopes; the tailings disposal cell will need this protection regardless of where it is located. The riprap for the side slopes and drainage ditches is large enough to resist flooding from the minimal flow velocities of floods occurring from a PMF on the Colorado River. A large rock apron has been designed to provide protection against the potential migration of Moab Wash and the Colorado River. The staff therefore concludes that the erosion potential at the site has been acceptably minimized, since any flooding at the site will be mitigated by the erosion protection, and the forces associated with offsite floods are minimal.

Criterion 4(b) states that topographic features should provide good wind protection.

The Atlas facility is located in an area that provides good wind protection due to the local topography. Cliffs on the western side of the facility rise abruptly for 1000 feet. To the north and east of the site are 500- to 600-ft high barren sandstone formations. The

prevailing wind direction is westerly to southwesterly. Records indicate that wind speeds are quite low, blowing under 6 miles per hour 50 percent of the time. Also, to minimize the effects of wind erosion, the tailings will be covered with a soil/rock matrix over the radon barrier. The staff considers that the site will be adequately protected from wind erosion by placement of this engineered riprap layer that protects the tailings from surface water erosion. Studies performed for the NRC have shown that an engineered riprap layer designed to protect against water erosion will be capable of providing adequate protection against wind erosion.

Criterion 4(c) states that cover slopes must be relatively flat after stabilization to minimize erosion potential and to provide conservative factors of safety assuring long-term stability. In general, slopes should not be steeper that 5H:1V.

The relatively flat top and side slopes of the covers will be protected from erosion by an engineered riprap layer designed to provide long-term stability (see Section 4.3). The erosion potential of the covers will be minimized by the design of the rock to be sufficiently large to resist flooding and erosion, based on the slope selected. Thus, the staff concludes that the slopes, with their corresponding rock designs, will be sufficiently flat to meet this criterion.

Criterion 4(d) requires a full self-sustaining vegetative cover be established or a rock cover employed to reduce erosion to negligible levels. The rock cover design must include consideration of such factors as the shape, size, composition, and gradation of the rock particles; rock cover thickness and zoning of particle size; and steepness of underlying slopes. The rock must be good quality.

Due to the arid nature of the site, the licensee made no attempt to substantiate self-sustaining vegetation over a 1000-year period. The contaminated tailings will be protected from flooding and erosion by an engineered rock riprap layer. The riprap has been designed in accordance with the guidance suggested by the staff (NRC 1990). As discussed in Section 4, the staff considers that erosion protection which meets that guidance will provide adequate protection against erosion and dispersion by natural forces over the long term. Adequate protection is provided by: (1) selection of proper rainfall and flooding events; (2) selection of appropriate parameters for determining flood discharges; (3) computation of flood discharges using appropriate and/or conservative methods; (4) computation of appropriate flood levels and flood forces associated with the design discharge; (5) use of appropriate methods for determining erosion protection needed to resist the forces produced by the design discharge; (6) selection of a rock type for the riprap layer that will be durable and capable of providing the necessary erosion protection for a long period of time; and (7) placement of a riprap layer in accordance with accepted engineering practice and in accordance with appropriate testing and quality assurance controls.

As discussed in Section 4, the staff can not conclude that the proposed rock cover provides the necessary protection until the open issues that are identified in that section are resolved.

Criterion 4(e) requires that the impoundment not be located near a capable fault that could cause a maximum credible earthquake larger than that which the impoundment could reasonably be expected to withstand.

The staff evaluations of the structural stability of the disposal cell considered the effects of earthquakes. As discussed in Sections 2 and 3, the staff is unable to conclude that the impoundment could withstand the acceleration from an assumed maximum credible earthquake on the northeast trending fault without more information from the licensee.

On the basis of independent reviews and analyses, the staff can not conclude that all the requirements of Criterion 4 will be met by the licensees's proposed reclamation plan.

Criteria 5, 7, and 13

Criteria 5, 7, and 13 concern ground-water protection. As previously discussed, ground water is being addressed under separate licensing actions. However, ground-water protection standards at the site will be in accordance with these criteria.

Criterion 6

Criterion 6 sets forth performance criteria for the disposal of tailings.

Criterion 6(1) requires that waste disposal areas be closed in accordance with a design which provides reasonable assurance that average releases of radon-222 and radon-220 to the atmosphere will be limited to 20 picocuries per square meter per second (pCi/m^2sec). The design is to be effective for 1000 years to the extent reasonably achievable and, in any case, for at least 200 years.

The evaluation of the radon barrier utilized the RADON computer code (NRC 1989b) and acceptable parameters, except as noted, to estimate radon emanation from the contaminated materials. The design is supported by adequate construction specifications, settlement monitoring, and quality control programs. The cover design is acceptable, and the average releases of radon-222 and radon-220 to the atmosphere will meet the criterion.

The design basis events for erosion protection features protecting the radon barrier are the PMP and the PMF events. Both of these events are considered to be the most severe that are reasonably possible and thus provide reasonable assurance of not being exceeded during the 1000-year design life. The erosion protection features should assure that excessive erosion does not occur during the design life. However, the staff can not conclude that the erosion protection features will be effective for the 1000 year design life until the open issues identified

in Section 4 are resolved.

The design basis event for seismic stability is the maximum credible earthquake on the northeast trending fault. This event is considered the most severe seismic event reasonably possible that could affect the site. It is extremely unlikely that it will be exceeded during the 1000 year design life. However, the staff can not conclude that the tailings cell will withstand the maximum credible earthquake until the open issue identified in Section 3 is resolved.

Criteria 6(2) and 6(3) require the licensee to verify by testing, as soon as reasonably achievable after placement of the final radon barrier, or portions of the final radon barrier, the effectiveness of the radon barrier in limiting radon releases. Criterion 6(4) requires the licensee to report the results of the verification within 90 days of completion and to maintain the pertinent data and calculations.

The licensee will be required to verify the effectiveness of the radon barrier by using the procedures described in 40 CFR part 61, appendix B, Method 115, or another method, if approved by NRC, and to report the results to NRC.

Criterion 6(5) precludes the use of materials containing elevated levels of radium within the top three meters of the cover.

As discussed in Section 6, only clean material, from excavations to re-contour Moab Wash and from offsite, will be used in the top three meters of the cover.

Criterion 6(6) imposes the long-term design requirements of Criterion 6 to all portions of the disposal site that contain a concentration of radium in land, averaged over areas of 100 square meters, which exceed the background level by 5 picocuries per gram (pCi/g) averaged over the first 15 centimeters below the surface and 15 pCi/g averaged over each 15 centimeter layer more than 15 centimeters below the surface.

The cleanup of contaminated areas is required by License Conditions Nos. 21 and 39 of Source Material License SUA-917. The cleanup will result in no areas outside the disposal cell exceeding the limit.

Criterion 6(7) requires that the licensee control, minimize, or eliminate post-closure escape of nonradiological hazardous constituents.

The radon barrier design includes a low permeability clay layer which will also serve to limit infiltration into the disposal cell. As a result, seepage of nonradiological hazardous constituents from the disposal cell will be minimized to the extent necessary to prevent threats to human health and the environment.

Criterion 6A

Criterion 6A requires the final radon barrier to be completed as expeditiously

as practicable considering technical feasibility and that completion dates for the radon barrier and interim milestones be established in the license.

Milestones for the completion of the radon barrier are identified in License Condition No. 55 of Source Material License SUA-917.

Criteria 9 and 10

Criteria 9 and 10 require that a financial surety arrangement be established to assure that sufficient funds are available to carry out the decontamination and decommissioning of the facility and the reclamation of the disposal area, and to cover the payment of the charge for long-term surveillance and control by the long-term custodian of the site.

The licensee's currently approved surety instrument, a performance bond issued by the Acstar Insurance Company of New Britain, Connecticut in favor of the NRC, is in the amount of $6,500,000 for the purpose of complying with Criteria 9 and 10. The licensee also maintains a Standby Trust arrangement for the benefit of NRC, with Norwest Bank of Colorado N.A.

Within 3 months of approval of the reclamation plan for the disposal area, Atlas is required to submit a revised cost estimate. If estimated costs in the newly approved plan exceed the amount covered in the existing financial surety, the licensee is required to have a new surety instrument in place within 3 months of NRC approval of the new cost estimate. (License Condition No. 42 of Source Material License SUA-917.)

Criterion 12

Criterion 12 requires that the final disposition of tailings or wastes at milling sites should be such that ongoing active maintenance is not necessary to preserve isolation.

As discussed in Section 4, the staff considers that the erosion protection should not require active maintenance over the 1000-year design life, for the following reasons: (1) the riprap has been designed to protect the tailings from rainfall and flooding events which have low probabilities of occurrence over a 1000-year period, resulting in no damage to the layers from those rare events; (2) the rock proposed for the riprap layers is designed to be durable and is not expected to deteriorate significantly over the 1000-year design life; and (3) during construction, the rock layers will be placed in accordance with appropriate engineering and testing practices, minimizing the potential for damage, dispersion, and segregation of the rock. However, the staff can not conclude that the erosion protection features will be effective for the 1000 year design life without active maintenance until the open issues identified in Section 4 are resolved.

As discussed in Sections 2 and 3, the staff also considers that the site should not require active maintenance to mitigate the effects of geologic, including seismic, disturbances. However, the staff can not conclude that the design will not require active maintenance to mitigate geologic disturbances during the 1000 year design life until the open issues identified in Sections 2 and 3 are resolved.

6.0 RADON ATTENUATION

6.1 Introduction

This section presents the staff evaluation of the radon barrier design aspects of the Reclamation Plan and Specifications, and its revisions (Atlas June 1992, April 1993, May 1994, March 1995) for the Moab, Utah, Title II Project site. The staff review was conducted in accordance with the guidance in the SRP (NRC 1993). The staff review of the radon attenuation design of the disposal cell cover is to ensure compliance with the long-term radon flux standard in Criterion 6 of Appendix A to 10 CFR Part 40. The other disposal cell radiological requirements of Criterion 6 (gamma levels, cover radionuclide concentration) were also considered, but the site cleanup plan was reviewed with the Decommissioning Plan.

The NRC staff review of the cover design for radon attenuation included an evaluation of the pertinent design parameters for the contaminated materials and radon barrier soil. The other layers of the cover (6-inch filter/bedding on side slopes and 4 to 9-inch rock erosion protection) were evaluated for their ability to protect the radon barrier layer from drying and disruption by considering the long-term effects of freeze-thaw damage and biointrusion. The erosion protection aspects of the cover design are discussed in Section 4 of this report.

Staff considered that the barrier layer thickness is also designed to satisfy criteria for construction, settlement, cracking, and infiltration of surface water. The barrier layer's potential for disruption due to settlement or heaving of the cell was also considered. These aspects of cell design are discussed in Section 3 of this report.

Radon (Rn-222) is an inert gas resulting from the radioactive decay of radium (Ra-226). Because radon has a short half-life (3.8 days), the amount of radon from uranium mill tailings reaching the atmosphere is reduced by restricting the gas movement long enough so that radon decays to a solid daughter which remains within the disposal cell. Most of the radon from deeply buried tailings decays before reaching the cell cover. The estimated long-term (at least 200 years from now) radon emanation rate (flux) from the disposal cell cover averaged over at least a one year period is calculated by utilizing a computer code (RAECOM or RADON). The code can also be used to calculate the radon barrier thickness required to limit the flux to a set value. The radon flux model (sequence of parameter values for input into the code) is based on the cell design adjusted for long-term or conservative conditions.

6.2 Evaluation of Model Parameters

The thickness of the earthen cover required to limit radon emission to meet the standard depends on the characteristics (physical and radiological) of the radon barrier soils and approximately the upper 15 feet of contaminated materials. The materials parameters used in the computer code include: material thickness, density, porosity, specific gravity, long-term moisture content, and radon diffusion coefficient. In addition, Ra-226 activity

concentration and radon emanation fraction of the various types of contaminated materials are important parameters of the radon model (Table 6-1).

NRC staff evaluated the physical and radiological test data for the contaminated materials and the radon barrier soils used by Atlas for input into the computer code. In some cases, estimates instead of measured values were used for input, and in other cases measurements were made, but not under design conditions. NRC staff evaluated the justification and assumptions made for each input value to confirm that each value was representative of the material or conservative, consistent with site construction specifications, and based on long-term (at least 200 years) conditions. Particular attention was given to the estimated long-term moisture content of the materials in the cell because this can be the most important single factor controlling radon movement.

6.2.1 Characterization of Materials

The radiological characterization programs for the site were conducted in 1988 and 1992. Sampling locations are shown on sheet 2 of 10, Drawing 88-067-E64 (April 23, 1993). All borehole logs and pertinent data used in the cover design are contained in Appendix A of the June 4, 1992, submittal (except the Ra-226 data for the "affected" material), as modified by the April 14, 1993, submittal.

The characterization program for the tailings pile (1992) consisted of six test borings on the top slope to depths up to 8 feet. The samples collected were grouped into three material types; ore (3 samples), coarse sand tailings (16 samples), and fine tailings (12 samples). The Reclamation Plan indicates that samples for each material type were composited and three samples for each type were tested. When staff questioned the appropriateness of this procedure, Atlas provided the written procedure (March 1995) that indicates each composite sample was formed from different samples and committed to revising pages B7 and B8 of the Reclamation Plan to clarify how the composite tailings and ore samples were constructed. Laboratory testing included specific gravity, radium activity, emanation coefficient, diffusion coefficient, in-place density and moisture, gradation, and capillary moisture relationships.

Soil samples from Moab Wash were obtained from 15 pits and grouped into "affected" and "clean" soils. The licensee defines "affected" soil as including any soil in the mill area, boneyard, or outlying area that exceeds the radium concentration of 5 picoCuries per gram (pCi/g) above background in soil that will remain in the upper 15 cm of soil, or exceeds 10 pCi/g above background in 15 cm layers of soil that will be below the surface after reclamation. Clean soil (i.e., uncontaminated sandy soil) will be obtained from the reconfiguration of Moab Wash and used for the upper layer of the radon barrier.

A composite sample was constructed from three samples of "affected" (contaminated) soils, and another composite sample was constructed from eight samples of clean soils. Atlas indicated that the samples selected were

coarser than the average borrow soils to provide conservative test results. The composite samples were divided into three splits, and each of these was then divided in half for geotechnical and radiological testing. Laboratory testing included specific gravity, gradation, compaction, diffusion coefficient, and, for the "affected" soils, radium activity concentration and radon emanation coefficient. In addition, three composite samples were taken from a proposed borrow located on Atlas property west of the tailings disposal area. This material represents an alternative source of sandy soil and was tested for specific gravity, gradation, compaction, capillary moisture relationship, and diffusion coefficient.

The design of the Atlas radon barrier utilizes a clay layer for the lower portion of the barrier. Three clay samples were collected at the Klondike Flat area, a potential source of this clay material, located about 13.8 miles north of the facility. Laboratory testing included specific gravity, gradation, diffusion coefficient, compaction, permeability, and capillary moisture relationships. The porosity value for all materials was calculated from the dry density and the measured or assumed specific gravity. However, the exact location of the clay borrow site has not been chosen. As discussed in Section 6.2.3 of this report, staff determined that additional testing of the final clay borrow material is required.

6.2.2 Parameters for Contaminated Materials

Affected Soil

Staff considers the parameter input values for the "affected" soil that are based on test values to be questionable because the sampling procedure may not have provided representative material. Staff previously had questioned whether a Ra-226 value based on a composite of three samples could adequately characterize the large amount of "affected" soil which includes tailings slurry spillage (NRC letter of November 4, 1994). Atlas responded that the particle size and saturation of the "affected" soil are more critical parameters in the radon model than the Ra-226 concentration and that the volume of soil with high levels of Ra-226 will be small when compared to the large volume of windblown soil with near background levels of Ra-226. Atlas also indicated that the three samples tested were the coarsest samples taken so that the values would be conservative. Staff agrees with Atlas that soil saturation and the large volume of windblown material are important but considers that coarse samples do not yield conservative values for the Ra-226 and diffusion coefficient parameters. However, further justification of the parameters values is not warranted because Atlas has resolved the issue of the "affected" soil sampling procedure resulting in unrepresentative parameter values by committing (March 1995) to test the "affected" soil after it is placed in the cell.

In the testing program, Atlas proposes to take samples at 15 locations from the upper and lower half of the "affected" soil layer in the disposal cell. Each sample will be analyzed for grain-size distribution, in-place density and moisture content, specific gravity, Ra-226 concentration, and emanation fraction. In addition, three samples of varying coarseness will be tested for diffusion coefficient. Staff suggests that the samples used for the diffusion

coefficient analysis be representative of the layer being modeled, as the grain-size affect on the diffusion coefficient has already been documented in NUREG/CR-3533 (NRC 1984).

Atlas stated that the test results will be reported to NRC prior to starting construction of the clay layer of the radon barrier. If the test data differ significantly from the parameter values used to model the radon barrier design in the Reclamation Plan, Atlas will evaluate the radon barrier thickness for adequacy to reduce radon flux to the regulatory criterion and adjust the barrier thickness accordingly. Staff considers that, because of the Atlas commitment to do further testing, the proposed radon flux model values for "affected" soil are acceptable at this point, but revisions may be required when the final layer thickness and the characteristics of the "affected" soil placed on the cell are known.

Ore Material

The ore layer in the disposal cell (periphery of top slope) consists of pieces of ore up to 6 inches in diameter. Testing of the ore was presumably done on finely crushed samples which should provide conservative radon emanation and long-term moisture values. Staff determined that this thin layer of ore is of limited importance for the radon model and the parameter values chosen by Atlas appear reasonable.

Tailings

The dry density parameter value for fine tailings is the average in-place dry density adjusted to account for the overburden stress from the relocated coarse sands and the cover system. The measured dry density of the coarse tailings was not adjusted as the effect of overburden stress would be insignificant for this material. Staff considers the values acceptable and notes that the density value is somewhat conservative for the 7 feet of coarse tailings that will be compacted to 90 percent on top of the fine tailings.

The Ra-226 values for top slope fine and coarse tailings were derived from samples composited over depth which is an appropriate method only if there is evidence that the Ra-226 concentration is fairly homogeneous. This is because the computer code used to calculate the estimated long-term radon flux is sensitive to the vertical distribution of Ra-226 in approximately the upper 15 feet of contaminated material, reflecting the attenuation of radon in deeper layers. Based on the annual processed ore grade data submitted by Atlas, NRC staff determined that the upper 2 feet of tailings should have approximately twice the concentration of Ra-226 as some lower layers. Atlas subsequently provided a radon model (March 1995, Appendix G) that reflects this layering by Ra-226 concentration in the fine tailings.

Atlas did not alter the Ra-226 value for coarse tailings because Atlas assumed that sufficient mixing of these tailings should occur during recontouring of the cell. Staff determined that, as suggested by Atlas (March 1995), the sampling plan for Ra-226 analysis should include taking samples of the upper 3 to 4 feet of coarse tailings. In addition, Atlas should provide supporting data or justify why the coarse tailings on the sideslopes were modeled as

being homogenous (i.e., a single layer) for Ra-226 concentration. Otherwise, staff considers that a Ra-226 input value for the coarse tailings should be 291 pCi/g instead of 241 pCi/g. Staff derived this value by assuming that the upper 6 feet of coarse tailings on the top slope are mixed during reconfiguration of the cell (calculated from the ore grade processed from 1980 to 1984).

The long-term moisture content value for the coarse tailings was based on the results from capillary moisture testing. The average value of 4.4 percent is conservative and, therefore, acceptable. The in-place moisture content reported for the fine tailings was 27.7 percent and the resulting average moisture of 30.9 percent under 15 bar pressure indicates that the test procedure and/or test results may not be appropriate to estimate the long-term moisture content for fine-grained materials. Based on a review of available data from similar sites, NRC staff recommended that 24 percent moisture be used for fine tailings in the model. The licensee agreed (March 1995) and provided a normalized diffusion coefficient value corresponding to this moisture level for the fine tailings.

The measured diffusion coefficient values for the tailings used in the model are not as conservative as the long-term moisture values and are not conservative (low) when compared to the code-calculated diffusion coefficient. This has not been raised as an issue but was considered by staff in the evaluation of the degree of conservatism in the various aspects of the radon flux model. Parameter values for the tailings are acceptable to staff but the Ra-226 values for the coarse tailings (top and side slopes) must be substantiated as indicated above.

6.2.3 Parameters for Radon Barrier Soils

Moab Wash Soil

Most of the parameter values for geotechnical properties for the uncontaminated Moab Wash sandy soils were the average test results of three splits of a composite sample. Staff determined that the samples taken should be representative of the available borrow material and that the testing is acceptable for the geotechnical parameters.

The density and porosity values used in the model are within the expected range for sandy soil and are acceptable to staff. The long-term moisture content of 2.8 percent was calculated using the Rawls and Brakensiek equation (NRC 1989) and is conservative considering the nature of the material and also considering that the placement moisture should be approximately 8 to 10 percent.

The diffusion coefficient value was determined from tests on samples with moisture contents (percent dry weight) that were less than the long-term moisture value. Therefore, staff considers this value acceptable.

Staff expressed concern (November 4, 1994) that windblown contamination might remain in Moab Wash soil excavated for the sandy soil layer of the radon barrier. This concern is based on Atlas' reliance on gamma surveys to

distinguish tailings contamination. Gamma meter readings do not correlate well with soil Ra-226 concentrations in the range of concern for windblown tailings cleanup (5-20 pCi/g Ra-226). Therefore, a thorough gamma survey and a conservative gamma level would need to be employed to avoid leaving significant contamination in the Moab Wash borrow area. Another concern regarding the potential for residual contamination is the definition of background Ra-226 in the Reclamation Plan. The construction specifications indicate that the background Ra-226 value is "the average value plus two standard deviations." Such a definition would allow unwarranted amounts of Ra-226 to remain in the sandy soil that will be placed in the cover. Radiological contamination of the cover would not comply with Criterion 6 which states that soils used for near surface cover must be essentially the same, as far as radioactivity is concerned, as that of surrounding surface soils. This is to ensure that the disposal cell surface radon exhalation is not significantly above background due to the cover material.

Atlas responded that the gamma radiation survey method was used to estimate the extent of contamination for design purposes and provides a conservative estimate. Staff will review the Atlas gamma survey method and the gamma meter reading correlation with soil Ra-226 concentration during soil cleanup verification. Atlas also indicated that the Reclamation Plan Construction Specifications will be revised to indicate that the soil background Ra-226 value is the average value approved by NRC. Staff notes that the definition of background Ra-226 also needs to be revised in the text (April 1993, page 40).

Atlas submitted a proposed plan for establishing a soil background Ra-226 value (March 1995, Appendix F), that is acceptable to NRC staff. Atlas stated that the radiological survey and sampling program will be incorporated into the Reclamation Plan and will be conducted to establish a background Ra-226 value for soil cleanup. The test results will be provided to NRC for approval, prior to using the Ra-226 value for cleanup verification. Alternatively, Atlas could propose a conservative background value based on data from neighboring sites. Either approach should allow Atlas to perform adequate cleanup of windblown tailings in Moab Wash and thus ensure that the sandy layer of the radon barrier contains background levels of Ra-226.

Klondike Flats Clay

The radiological and geotechnical parameter values for the clay (obtained in the Klondike Flats area) are the average results of testing performed on three samples. Atlas stated (March 1995) that the characteristics of the clay (Mancos Shale) were uniform throughout the formation and that DOE had used material from the same formation to construct the radon barrier at the Grand Junction Title I site. Atlas has not completed arrangements for a particular borrow source and relies on the construction specifications to support the radon barrier design in lieu of extensive borrow source characterization. The specifications describe prequalification procedures, as well as requirements for testing the source throughout construction. In addition, staff will require an adequate quality assurance program, as discussed below.

Based on a review of the physical properties, NRC staff determined that the parameter values for the clay were acceptable except for the long-term moisture value, as discussed below. The tested material met the proposed construction specifications for the clay layer of the radon barrier. When appropriate, the parameter values reflect placement conditions.

The long-term moisture content value resulting from averaging capillary moisture test results was 16.2 percent, but the average optimum moisture for this material is 15.1 percent. As indicated in the discussion of the fine tailings, there is some question as to the validity of applying results from this test procedure to this modeling application. The results from the capillary moisture test can not automatically be applied in the modeling process but should be compared to the results of other methods of estimating the long-term moisture content.

The licensee supported the use of capillary moisture test results by noting that the construction specifications require that the radon barrier material be placed at 2 to 5 percent greater than optimum moisture, making the projected minimum placement moisture approximately 17.1 percent. However, Atlas did not provide support for the expectation that the clay will retain a moisture content above optimum over the 1000-year design life in a semi-arid climate. Therefore, staff estimated the moisture content of the clay using the Rawls and Brakensiek equation. Construction specifications require that the clay material have a minimum of 75 percent fines (material passing a No. 200 sieve) and staff assumed, for input into the equation, that the minimum percent clay was 27 percent (the average of three samples) and that the material contained 1.0 percent organic content. The result of the Rawls and Brakensiek equation was an estimated long-term moisture content of 10.2 percent. This equation usually provides a conservative value compared to other estimation methods, so staff also considered data from other sites.

Staff considers that a moisture value of 14.7 percent (value used in the Grand Junction model) is appropriate for the clay layer of the radon barrier if supported by borrow source characterization and an acceptable construction quality control program. The quality control program should ensure that adequate measures are taken during construction to prevent excessive drying of the clay and should include adequate documentation (such as a summary sheet) to confirm the moisture content of the placed clay material. Staff is concerned that the clay layer of the cover could dry significantly before the next layer of soil is placed over it, thereby invalidating the model's long-term moisture value which is primarily based on the placement moisture.

Atlas stated (March 1995) that the NRC staff's recommended moisture content for the clay is acceptable and provides additional conservatism in the design. Atlas also stated that to provide additional assurance, the construction specifications will be revised to indicate that the clay is required to have an average in-place moisture content greater that 17 percent.

To address the concern for drying of the clay during construction, Atlas agreed (March 1995) to cover each lift of clay within 7 days of placement, or else moisture-condition and retest prior to covering. Atlas also committed to provide a summary sheet of the quality control testing of the radon barrier

(clay and sandy soil) during construction. Staff considers that the Atlas proposed 7-day limit before placing another layer over the clay, or moisture-conditioning may be too long, depending on the weather and the clay placement moisture. When successive lifts of fill are placed with interruption sufficient to cause drying, field tests should be performed to confirm moisture contents have not been adversely affected, prior to resuming placement. If excessive drying is noted, the surface should be scarified, moisture-conditioned, and recompacted as necessary.

Resolution of the long-term moisture issue requires that Atlas provide detailed construction specifications or a quality assurance program incorporating criteria (temperature, time interval, placement moisture) for field testing the moisture content of the radon barrier soils between lift placement. Alternatively, Atlas can designate a conservative 2-day limit on lift placement interruption without testing the moisture content.

Atlas adjusted the measured diffusion coefficient value for the clay in the proposed radon model (March 1995) to correspond to the revised moisture value. Staff notes that the Atlas diffusion coefficient value (0.00168 cm^2/s) is not conservative compared to the value (0.0025 cm^2/s) derived by the Department of Energy after extensive testing of the Grand Junction clay at the same moisture content approved for the Atlas clay. The low diffusion coefficient of the radon barrier clay is critical to Atlas' demonstration, through its radon barrier modeling, that the radon flux standard can be met. Any question as to the validity of this value is resolved due to the commitment by Atlas to do further testing of the clay borrow area (minimum 20 gradation and 3 diffusion coefficient tests) prior to construction of the clay layer. Before submitting the diffusion coefficient test results, Atlas should note that page 10 of Regulatory Guide 3.64 (NRC 1989) indicates that staff will accept measured radon diffusion coefficients if documentation of the precision and accuracy of the procedure is provided.

6.3 Calculational Methodology and Results

Atlas modeled the radon flux for the covered disposal cell utilizing the RADON computer code (NRC, 1989). For modeling and design purposes, Atlas divided the disposal cell into three areas: 1) the embankment (side slopes), which consists of coarse tailings; 2) coarse tailings in the peripheral portion of the impoundment (top slope); and 3) fine tailings within the central portion of the impoundment.

The licensee proposes to decrease the slope of the existing embankment by moving coarse tailings to the top resulting in a 7-foot-thick layer over the fine tailings. The fine tailings have a high Ra-226 concentration so the overlying thick layer of coarse tailings will reduce radon emanation from this source. The less contaminated material ("affected" soil) will be placed on top, next to the radon barrier, at least 16 inches deep. The side slopes are designed with a 7-foot-thick sandy layer for the radon barrier.

These models are somewhat conservative in that the radon attenuation resulting from the 6-inch filter layer on the sideslopes, and the 6-inch soil/rock layer on the top were not included. Also, Atlas noted that portions of the clean

dike fill and interim cover will remain in place, but other portions will be mixed with the "affected" soil layer and upper layer of tailings during excavation and regrading. The ultimate disposition of these clean materials cannot be easily quantified at this point but will provide additional radon attenuation capacity.

The Atlas radon flux models assume that the Ra-226 content of the clay and sandy layers of the radon barrier are zero. This is appropriate because the footnote to Criterion 6 (1) indicates that the flux standard applies only to emissions from byproduct materials. However, the footnote states that the radon emissions from covering materials should be estimated as part of developing a closure plan. In addition, Criterion 6 (5) indicates that "...soils used for near surface cover must be essentially the same, as far as radioactivity is concerned, as that of surrounding surface soils." Therefore, Atlas should provide data for the radon barrier soils substantiating that the Ra-226 levels are approximately background.

In response to NRC staff comments, Atlas proposed a revised radon barrier design for the top slope in March 1995 (see Figure 6-1), based on a revised radon model using more conservative parameter values. The radon barrier minimum thickness (clay plus sandy layers) has been increased from 12 inches to 17 inches over the coarse tailings area, and to 21 inches over the fine tailings area. The clay layer will be a minimum of 8 inches thick over the coarse tailings area and 12 inches thick over the fine tailings area. The clean soil layer minimum thickness has been increased from 6 inches to 9 inches over the entire top slope. Because the side slopes do not contain fine tailings or the clay layer, Atlas did not change the model for that area. The Atlas modeling results indicate that the long-term radon flux should be 19.1, 19.8, and 18.5 pCi/m^2s for the side slopes, fine tailings, and coarse tailings areas, respectively.

Staff considers the proposed barrier design acceptable contingent upon Atlas' commitment to substantiate several radon flux model parameters during construction. If the test values for the "affected" soil, coarse tailings, or clay are significantly different than values used in the Reclamation Plan flux model, Atlas will perform flux modeling that incorporates the new test values. If the results indicate that the long-term radon flux will not meet the standard, Atlas has committed to adjust the radon barrier thickness to ensure that the average radon emission from the disposal site will be limited to 20 pCi/m^2sec, as required by Criterion 6 (1) of 10 CFR Part 40, Appendix A.

6.4 Durability of the Radon Barrier

As discussed in previous sections, disruption of the radon barrier by wind or rain will be prevented by the erosion protection layer, and there is a low probability of major cracking of the cover due to differential settlement of the tailings. The clay layer of the barrier will be protected from significant cracking due to desiccation by the material placed above it and by the moisture-retaining properties of the clay.

Staff considers that the proposed clay layer thickness of at least 8 inches can be achieved in construction and should provide adequate limits on drying and cracking of the layer. The layer's integrity should be maintained because final soil cover placement will not begin until 90 percent of primary consolidation of the tailings has occurred (Atlas Technical Specifications Section 9.3.1, June 1992). This consolidation criterion will be determined by the owner and approved by the NRC.

Atlas indicated that biointrusion of the radon barrier will be restricted by the unfavorable environment of the rock layer in the final cover. Although it is recognized that some volunteer plant growth will occur, the licensee concluded that it will most likely be shallow-rooted grasses whose roots should not penetrate the 12 inches of cover materials above the clay layer. Animals indigenous to the area are not expected to select the reclaimed disposal area over native terrain for habitation. The rock cover will not be conducive to digging or to establishing vegetation to create an acceptable habitat. In addition, the tall slopes (about 100 vertical feet) surrounding the disposal area will be armored with rock which should discourage passage onto the upper portion of the disposal area. Staff concludes that the reclaimed facility will not provide a desirable habitat, therefore, the cover is unlikely to be significantly disrupted by burrowing animals or deep-rooted plants. Also, the site will be transferred to a custodial agency (either the State of Utah or the U.S. Department of Energy) that is required to perform long-term surveillance and maintenance. Any problems, such as extensive plant growth or disruption of the rock cover, that could affect the radon attenuation ability of the cover, would be addressed.

Atlas addressed the effect of freeze/thaw cycles on the radon barrier, and concluded that the clay will not be susceptible to frost heave, as the coarse tailings below it will not support capillary action. Therefore, the ability to transport excess water to the frost line does not exist, and the susceptibility of the cover system to frost heave can be considered low. Also, Atlas performed an analysis of potential frost penetration using the Modified Berggren equation method, as proposed by the U.S. Army Corps of Engineers Cold Regions Research and Engineering Laboratory (COE 1968). Using historical weather data in the equation, it was shown that potential damaging frost penetration of the radon barrier was unlikely, thus the proposed design need not be modified further for additional protection. NRC staff agrees that the data supports the licensee's conclusion that significant freeze-thaw damage is unlikely to occur to the clay layer of the radon barrier as described in the proposed design (see Section 3.3.4 for further discussion).

The licensee's conclusions as to the ability of the proposed borrow materials to perform adequately in the cover system are acceptable to staff, subject to review of the results of the proposed testing and acceptance of a quality assurance program for clay placement. Adequate design conservatism should ensure long-term radon barrier integrity, assuming that long-term stability of the disposal cell is achieved.

6.5 Measured Radon Flux

Criterion 6 (2) of Appendix A requires licensees to measure the average radon flux (minimum of 100 measurements) on the recently completed radon barrier to demonstrate that the radon flux criterion has been achieved. The flux limit is the same as that for the modeled (design) long-term radon flux. The measured flux on newly constructed radon barrier should easily meet the flux criterion because the materials contain, relative to later years, more moisture and fewer cracks. If the radon flux model or the barrier construction were seriously flawed, this would be reflected in the average measured radon flux. If the measured flux did not meet the criterion, staff could require corrective action such as additional radon barrier material.

6.6 Conclusions

At this time, staff considers that the radon barrier design proposed by Atlas (March 1995) can not be substantiated by the radon flux modeling results due to uncertainties in many of the model parameter values. Inadequacies in the sampling program, uncertainties in the method for differentiating contaminated ("affected") soil versus uncontaminated radon barrier soil in Moab Wash, uncertainties in the clay borrow source, and inadequate construction quality assurance specifications, require that more information be provided to confirm the design. Atlas' commitments to address the issues summarized below are considered adequate for preliminary acceptance of the radon barrier design except for the construction quality assurance program for the barrier soils. All issues must be resolved before Atlas initiates construction of the radon barrier portion of the cover.

In order to provide assurance that the long-term radon flux standard and other cover requirements of Criterion 6 will be achieved, Atlas should:

1. Provide revised pages B7 and B8 for the Reclamation Plan to clarify how the composite tailings and ore samples were constructed.

2. Test the "affected" soil after placement in the cell for grain-size distribution, in-place density and moisture content, specific gravity, Ra-226 concentration, emanation fraction, and diffusion coefficient. The test results should be reported to NRC prior to starting construction of the clay layer of the radon barrier.

3. Include the upper 3 to 4 feet of coarse tailings on the top slope in the sampling plan for Ra-226 analysis. Also, provide data or justification for the Ra-226 value used for the coarse tailings on the side slopes.

4. Provide an evaluation of the radon barrier thickness for adequacy to reduce radon flux to the regulatory criterion, if any of the test results on the placed "affected" soil, coarse tailings, or final clay borrow differ significantly from the parameter values used to model the reclamation plan radon barrier design (March 1995). Adjustments to the constructed radon barrier thickness would be made accordingly.

5. Revise the Reclamation Plan Specifications (Section 1.14 and 5.3.3) and page 40 of the text to indicate that the background soil Ra-226 value is the average value approved by NRC.

6. Conduct the radiological survey and sampling program to establish a background Ra-226 value for soil cleanup and provide the results to NRC for approval prior to cleanup verification.

7. Revise the construction specifications to indicate that the clay is required to have an average in-place moisture content greater that 17 percent.

8. Provide adequate, detailed construction specifications (or a quality assurance program) for field testing the moisture content of the radon barrier soils when lift placement is interrupted.

9. Test the final clay borrow material (minimum 20 gradation and 3 diffusion coefficient tests) prior to construction of the clay cover layer.

10. Provide data for the radon barrier soils substantiating that the Ra-226 levels (pCi/g) are approximately background.

TABLE 6.1

ATLAS RADON INPUT SUMMARY

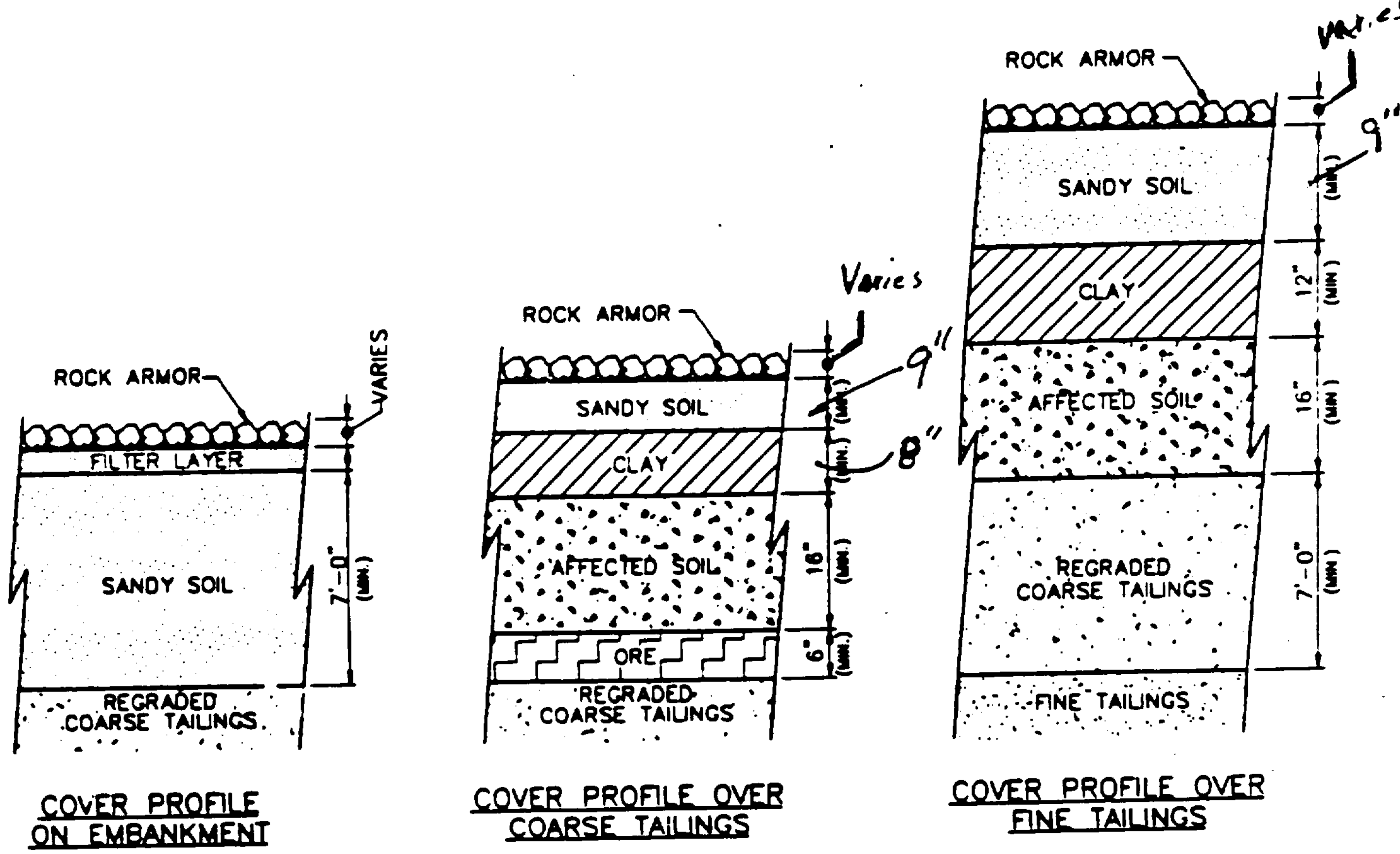
March 1995 submittal — spec. gravity: 2.7-2.9 measured

AREA/ MATERIAL	THICK-NESS (cm.)	POROS-ITY	DRY DENSITY (g/cm^2)	Ra-226 (pCi/g)	EMANAT. FRACT.	MOISTURE Percent (by wt.)	DIFF. COEFF. (cm^2/s)
FINE T.							
fines	123	.5057	1.44	893	.35	24	.00185
fines	129	.5057	1.44	1339	.35	24	.00185
fines	56	.5057	1.44	1938	.35	24	.00185
coarse	213.4	.435	1.53	241	.23	4.4	.0247
affected	40.6	.295	1.91	19.5	.28	2.8	.0197
clay	30.5	.3897	1.71	0	0	14.7	.00168
sandy	22.9	.3368	1.79	0	0	2.8	.021
FLUX 19.8							
COARSE T.							
coarse	500	.435	1.53	241	.23	4.4	.0247
ore	15.2	.3637	1.72	212.7	.28	9.0	.0083
affected	40.6	.2954	1.91	19.5	.28	2.8	.0197
clay	20.3	.3897	1.71	0	0	14.7	.00168
sandy	22.9	.3368	1.79	0	0	2.8	.021
FLUX 18.5							
SIDE SLOPE							
coarse	500	.435	1.53	241	.23	4.4	.0247
sandy	213.4	.3368	1.79	0	0	2.8	.021
FLUX 19.15							

FIGURE 6.1

RECLAIMED IMPOUNDMENT SOIL COVER PROFILES

March 21, 1995 Submittal
Figure 1, Drawing No. 88-067-A112



1995 PROPOSED MODIFICATIONS

NOTE:
1. THIS DRAWING IS NOT TO SCALE.

ATLAS - LISTING OF REFERENCES
SECTION 6

Atlas submittals - Project Manager has the letters
June 4, 1992
April 14, 1993
May 31, 1994
March 21, 1995

COE (U.S. Army Corps of Engineers), "Digital Solutions of Modified Berggren Equation to Calculate Depths of Freeze or Thaw in Multilayered Systems," CRREL Special Report No. 122, October 1968.

U.S. Nuclear Regulatory Commission Standard Review Plan, 1993. **(see TJ's for Detail)**

U.S. Nuclear Regulatory Commission, V.C. Rogers, et al., "Radon Attenuation Handbook for Uranium Mill Tailings Cover Design," NUREG/CR-3533, April 1984.

(Writer), U.S. Nuclear Regulatory Commission, letter to (Contact), Atlas Corporation, November 4, 1994.

U.S. Nuclear Regulatory Commission, Office of Nuclear Regulatory Research, "Calculation of Radon Flux Attenuation by Earthen Uranium Mill Tailings Covers," Regulatory Guide 3.64, June 1989.

November 30, 1995

MEMORANDUM TO: Peter J. Rabideau, Director
Division of Accounting and Finance
Office of the Controller

From: Daniel M. Gillen, Acting Chief (Original Signed By)
High Level Waste and Uranium Recovery
Projects Branch
Division of Waste Management, NMSS

SUBJECT: ATLAS CORPORATION LICENSE FEE LETTER

Attached for your action, is a letter dated November 28, 1995, from Richard Blubaugh, Atlas Corporation, to Joseph J. Holonich of the Division of Waste Management. Atlas states that, due to temporary cash flow difficulties, it will postpone paying its license fees until mid February 1996, at which time it will pay its fees in full plus interest.

Unless directed otherwise, we do not intend to suspend our ongoing licensing and environmental review of Atlas' proposed revised reclamation plan. Please advise us of any action you take with regard to this matter.

Attachment: As stated

cc: R. Blubaugh

CONTACT: Mike Fliegel, NMSS/DWM
415-6629

DISTRIBUTION w/Encl.: Central File NMSS r/f DWM r/f HLUR r/f
JHolonich LHowell, RIV

w/o Encl.: JSurmeier MFederline

DOCUMENT NAME: S:\DWM\HLUR\MHF\NOPAY.MHF

OFC	HLUR	E	HLUR	E					
NAME	MFliegel:cc		DGillen						
DATE	11/30/95	H	11/30/95	H					

OFFICIAL RECORD COPY

9512180159 951130
NMSS ADOCK 04003453
CF

April 8, 1996

The Honorable Richard G. Lugar
United States Senate
Washington, DC 20510-1401

40-3453

Dear Senator Lugar:

I am responding to your letter of March 7, 1996, to Mr. Dennnis Rathbun, which transmitted a letter to you from your constituent, Mr. Rod M. Bradfield, commenting on a Draft Environmental Impact Statement (DEIS) published by the U.S. Nuclear Regulatory Commission. The DEIS (NUREG-1531), "Related to Reclamation of the Uranium Mill Tailings at the Atlas Site, Moab, Utah," was published in January 1996 with a 60-day public comment period.

In response to public requests, the comment period has been extended 30 days, to April 29, 1996. Mr. Bradfield's letter to you will be treated as a comment letter on the DEIS and will be considered and addressed in the Final Environmental Impact Statement, as will all other comments we receive.

Mr. Bradfield's primary concern is with the use of rock quarried from Round Mountain in Castle Valley, Utah. As a result of the concerns expressed by many residents of Castle Valley, the Atlas Corporation, which has responsibility for cleanup of the Moab mill tailings, has decided to find another source of rock and no longer intends to quarry rock from Round Mountain.

I trust that this responds to your request.

Sincerely, Original signed by James M. Taylor

James M. Taylor
Executive Director for Operations

DISTRIBUTION w/Encl.: GT96164

File Center	NMSS r/f	DWM r/f	URB r/f	PUBLIC	LHowell RIV
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EDO r/f	NMSS Dir. Off. r/f		SECY-CRC-96-0249		

CP/PROOFED/MARCH 29, 1996

DOCUMENT NAME: S:\DWM\URB\MHF\LUGAR.RSP *See Previous Concurrence

OFC	URB*	TECH ED*	URB*	DWM*	NMSS
NAME	MFliegel/dh	EKraus	JHolonich	MFederline	CPaperiello
DATE	3/27/96	3/27/96	3/27/96	3/29/96	4/1/96
OFC	DEDS	EDO	OCA		
NAME	HThompson	JMTaylor	DRathbun		
DATE	4/5/96	4/6/96	4/8/96		

OFFICIAL RECORD COPY

150008

40-3453

9605130001 6 pp.

XA on 5/5/96

96-34

NH17

The Honorable Richard G. Lugar
United States Senate
Washington, DC 20510-1401

Dear Senator Lugar:

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James M. Taylor
Executive Director for Operations

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File Center	NMSS r/f	DWM r/f	URB r/f	PUBLIC	LHowell RIV
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EDO r/f	NMSS Dir. Off. r/f		SECY-CRC-96-0249		

CP/PROOFED/MARCH 29, 1996
DOCUMENT NAME: S:\DWM\URB\MHF\LUGAR.RSP *See Previous Concurrence

OFC	URB*	TECH ED*	URB*	DWM*	NMSS
NAME	MFliegel/dh	EKraus	JHolonich	MFederline	CPaperiello
DATE	3/27/96	3/27/96	3/27/96	3/29/96	4/1/96
OFC	DEDS	EDO	OCA		
NAME	HThompson	JMTaylor	DRathbun		
DATE	4/5/96	4/5/96	4/ /96		

OFFICIAL RECORD COPY

The Honorable Richard G. Lugar
United States Senate
Washington, DC 20510-1401

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Sincerely,

James M. Taylor
Executive Director
for Operations

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PUBLIC ✓ LHowell RIV DWM t/f URB t/f CPoland JTaylor
HThompson EDO r/f DMorris
DOCUMENT NAME: S:\DWM\URB\MHF\LUGAR.RSP TICKET EDO GT96164 CRC NO. 96-0249

OFC	URB	TECH ED	URB	DWM	NMSS
NAME	MFliegel/dh	EKraus	JHolonich	MFederline	CPaperiello
DATE	3/27/96	3/27/96	3/27/96	3/29/96	3/ /96

OFC	OCA	DEDS	EOD		
NAME	DRathbun	HThompson	JTaylor		
DATE	/ /96	/ /96	/ /96		

OFFICIAL RECORD COPY

The Honorable Richard G. Lugar
United States Senate
Washington, DC 20510-1401

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James M. Taylor
Executive Director
for Operations

DISTRIBUTION w/Encl.: File Center NMSS r/f DWM r/f URB r/f
PUBLIC LHowell RIV DWM t/f URB t/f CPoland JTaylor
HThompson
DOCUMENT NAME: S:\DWM\URB\MHF\LUGAR.RSP TICKET EDO GT96164 CRC NO. 96-0249

OFC	URB		TECH ED		URB		DWM		NMSS	
NAME	MFliegel/dh		EKraus		JHolonich		MFederline		CPaperiello	
DATE	3/ /96		3/ /96		3/ /96		3/ /96		3/ /96	
OFC	OCA		DEDS		EDO					
NAME	DRathbun		HThompson		JTaylor					
DATE	/ /96		/ /96		/ /96					

ACTION

EDO Principal Correspondence Control

FROM: DUE: 04/03/96 EDO CONTROL: GT96164

DOC DT: 03/07/96

FINAL REPLY: 3/29/96

Sen. Richard G. Lugar

TO:

Dennis Rathbun, OCA

FOR SIGNATURE OF : ** GRN ** CRC NO: 96-0249

Executive Director

DESC:

ENCLOSES LTR FROM ROD M. BRODFIELD RE URANIUM MILL TAILINGS

ROUTING:

Taylor
Milhoan
Thompson
Blaha

DATE: 03/21/96

ASSIGNED TO: CONTACT:

NMSS ~~Paperiello~~

SPECIAL INSTRUCTIONS OR REMARKS:

Reply in duplicate & return incoming with reply.
Mark envelope ATTN:Darlee Williams.

DWM Action
Due to NMSS Director's Office
By 3/29/96
rec'd 3/22/96

Flegel
Mike, see me b4 you start to write for

ACTION: Holonich
Due to DWM
Director's Office: 3/28/96

cc: Federline
Weber

3/25
3/25 rcs

OFFICE OF THE SECRETARY
CORRESPONDENCE CONTROL TICKET

PAPER NUMBER: CRC-96-0249 LOGGING DATE: Mar 14 96

ACTION OFFICE: EDO

AUTHOR: SEN. RICHARD LUGAR
AFFILIATION: U.S. SENATE

ADDRESSEE: DENNIS RATHBUN

LETTER DATE: Mar 7 96 FILE CODE: MH&S 11 URAN. MILL.

SUBJECT: URANIUM MILL TAILING

ACTION: Signature of EDO

DISTRIBUTION:

SPECIAL HANDLING: OCA TO ACK

CONSTITUENT:

NOTES:

DATE DUE: Apr 4 96

SIGNATURE: DATE SIGNED:
AFFILIATION:

EDO -- GT96164

RICHARD G. LUGAR
INDIANA
306 HART SENATE OFFICE BUILDING
WASHINGTON, DC 20510
202-224-4814

United States Senate

WASHINGTON, DC 20510-1401

COMMITTEES
AGRICULTURE, NUTRITION, AND FORESTRY
CHAIRMAN
FOREIGN RELATIONS
SELECT COMMITTEE
ON INTELLIGENCE

March 7, 1996

Mr. Dennis Rathbun
Office of Congressional Affairs
Nuclear Regulatory Commission
11555 Rockville Pike
Rockville, Maryland 20852

Dear Mr. Rathbun:

Because of the desire of this office to be responsive to all inquiries and communications, your consideration of the attached is requested.

Your findings and views, in duplicate form, along with the return of the enclosure, will be greatly appreciated. Please direct your reply to the attention of Darlee Williams of my Washington office.

Thank you for your thoughtful attention.

Sincerely,

Dick Lugar

Richard G. Lugar
United States Senator

RGL/dwl
enclosure

XA on 5-15-96

9605130003 XA

PRINTED ON RECYCLED PAPER

Rod Bradfield
1201 South Center Street
Terre Haute, Indiana 47802

96 MAR -4 PM 3:02

January7,1978

Senator Richard Lugar
306 Senate Hart Office Building
Washington, D.C. 20510-1401

Dear Senator Lugar;

I am impressed with the effort put into the January, 1996 Draft Environmental Impact Statement Relating to Reclamation of the Uranium Mill Tailings at the Atlas Site, Moab, Utah, NUREG-1531. After reading the DEIS, I am writing to state my support for the alternative plan (moving the Atlas tailings to the Plateau Site), opposing the proposal to leave the Tailings at the Atlas Site.

Except for the issue of using Round Mountain in Castle Valley as a Borrow Site for caprock at the Atlas site, I approached the DEIS from as neutral a viewpoint as possible. However, in almost all comparisons of environmental impact between the Atlas Site verses the Plateau Site, the point is made that 'some' present or future impact will or could likely occur at the Atlas Site, while little or no present or future impact would occur at the Plateau Site, other than temporarily losing a few hundred acres of cattle grazing land. As a specific example of the differences between the Atlas site and the Plateau site, seismicity at the Atlas Site remains an unresolved issue. (no such seismic problem exists at the Plateau site). Section 4.2, pages 4-6 and 4-7 of the DEIS states:

"In summary, the draft TER (NER 1996) lists the following unresolved geologic issues related to the Atlas site: "(1) capability of the Moab fault and its branches, (2) the nature of a buried scarp at the Atlas site, (3) the rate and nature of subsidence, (4) the effects of migrating sand dunes, (5) the effect of landslides emanating from Poison Spider Mesa, and (6) the seismic design basis."

In another specific example, section 2.4.2, page 2-25, states:

"Tailings leachate seepage would continue to contribute small amounts of contaminates to the river, which, based on the analyses presented in Sections 4.4, 4.5, and 4.6, would not measurably or adversely effect water quality or aquatic biota beyond a small mixing zone. Under the Plateau site alternative, virtually no contaminates would enter area surface water once reclamation and ground water cleanup at the Atlas site are completed."

Since the purpose of the Nuclear Regulatory Commission, as I understand it, is to manage thorough cleanup of contaminated sites in the best manner possible, it makes sense to use the Plateau Site. Cleanup would be more thorough and the Plateau site is seismically more stable and far from the Colorado River with its potential flood and leachate problems. The DEIS offers several projections of leaching and break down of the Atlas site in flood, earthquake or

landslide situations, stating that such leaks or breakdown would pose only a minimal threat to the environment. Again, when an alternative disposal site is available that all but eliminates such threats, being geologically and hydrologically more stable over a longer period of time, it behooves the parties involved to use the alternative site. Cost considerations, while important, should be secondary to preventing even minimal environmental impact.

Regarding costs, I note that the Plateau site alternative proposal would use the existing railroad between the Atlas site and Plateau site, running alongside U.S. highway 191, for transport of material from Atlas to the Plateau site. In the Atlas plan, a rail spur of approximately 3.3 miles would then be constructed at the Plateau end of the railroad to complete a rail journey to the Plateau site. Figure 2.2-1, page 2-15 of the DEIS shows a road already in place that could possibly handle truck hauling from the railroad to the Plateau site, 3.3 miles away. Using trucks from the end of the current railroad to the Plateau site could eliminate the need for an additional rail spur, perhaps cutting the cost of the Plateau proposal considerably.

The above examples discuss overall concerns regarding which available alternative would be the best all around solution. On a more personal level, however, I am most concerned with, and in opposition to, the lease by the Atlas Corporation at Round Mountain in Castle Valley, Utah, to obtain igneous rock for use as capstone on the Atlas site proposal. As a property owner in Castle Valley who purchased the property primarily for its remarkable and pristine view, with plans to be a resident after retirement (10 years plus), I am extremely concerned about the aesthetic effects of the Atlas lease on the Valley.

The view from within Castle Valley is outstanding. From our lot, the La Sal Mountains to the southeast can be seen through the subtle haze of distance. Round Mountain, while smaller, is closer and more clearly defined. On closer inspection, Round Mountain, a darker, volcanic intrusion in the midst of lighter sandstone strata, is unique in the area (Atlas chose this site for borrow material because sandstone is not suitable, and few igneous or metamorphic sites exist in the area). The volcanic rock of Round Mountain contrasts dramatically against the tree covered La Sals; sparsely vegetated red sandstones of Castle Butte, Priest and Nuns spires and buttes forming the northern edge of the Valley; the variegated, medium brown sandstones of Porcupine Rim, running the entire length of the southwest edge of the valley); and the red, sandy valley floor, dotted more frequently with Pinyon and Juniper as the valley gently rises toward the La Sals. Such contrasts give Castle Valley its highly unique aesthetic quality. This uniqueness makes it a most desirable location to visit and live in, attracting property buyers, tourists, film makers and others.

True preservation of the unique beauty of Castle Valley can only be accomplished by careful planning right from the beginning of settlement. The Castle Valley Property Owners Association, recognizing the need for such preservation has developed guidelines for property owners to maintain the unique quality of the valley as more homes are built. The same must hold true for any use of state and federal lands, when pressures build to utilize them for mineral or rock extraction or other purposes. Extreme care must be exercised to assure that aesthetics (as well as ecology) are not compromised.

In the West, as elsewhere, property values are influenced by the available view, as well as by closeness of neighbors, industrial, commercial and mining development, and total population. At present, Castle Valley is somewhat regulated in terms of lot size, industrial / commercial development and other intrusive activities such as mining or quarrying. This has been done to balance growth in such a way as to preserve the Valley's beauty. Visible scarring from quarrying operations by Atlas would inevitably effect property values.

While Round Mountain itself is state land, it nevertheless falls within the 'view' of residents of Castle Valley and travelers along the La Sal Mountain Loop Road and atop Porcupine Rim. This encompasses more than the southeastern view of Round Mountain from the residential portion of the Valley. Along the La Sal Mountain Loop road, numerous other views of Castle Valley occur, providing a clearer picture of the Valley as a whole, and a nearly complete (360°) view of Round Mountain. Outstanding views from Porcupine Rim, a mostly 4-wheel drive area, completes the circumference view of the mountain. La Sal Mountain Loop Road, and to a lesser degree, Porcupine Rim are used by numerous tourists in the area, with the Loop Road touted in most Moab tourist literature. The borrow operations proposed by Atlas could not avoid damaging such an extensive, all around view of the mountain.

Damage to the aesthetics of Castle Valley is mentioned in Section 4.7.4.3 of the DEIS:

> *"The riprap operations proposed for Round Mountain would likely have substantial negative aesthetic effects on residents of Castle Valley and on visitors to the area. Post reclamation, the borrow activities would create scars that would likely take tens of years to weather and revegetate sufficiently not to bear strong indications of the operations."*

The above paragraph, with its use of the word 'substantial', is a strong statement regarding environmental consequences of quarrying borrow rock from Round Mountain, yet, to my knowledge, no public hearings have been held regarding this plan. Minutes and accompanying information from the Castle Valley Property Owners Association 1995 Annual POA Meeting state that the Atlas company went to the State Land Board to obtain a lease to mine 'building stone' from Round Mountain, instead of a lease for borrow material. Apparently, a lease for 'building stone' does not require a public hearing (a public hearing would have brought up objections and difficulties Castle Valley residents and property owners have with the Round Mountain proposal). I believe that such public discussion would have had a negative effect on granting a lease for taking any material from Round Mountain, stopping the plan before its inclusion in the DEIS. Since there was no public hearing, however, residents and property owners have had no say in the granting of the lease at Round Mountain, even though, as the DEIS clearly points out, long term negative aesthetic impact will be the result. Castle Valley residents and property owners have had no say in this aspect of the future of their Valley.

It is patently unfair, if not suspect, therefore, of Atlas to request a lease type which does not require public input from residents, property owners and others involved. Given the 'substantial negative aesthetic effects' on Castle Valley, it is paramount to determine public sentiment regarding present and future negative impacts of any proposed quarrying operation. The Atlas company should be required either to obtain a lease for the actual purposes it intends

se Round Mountain for (borrow material), thus incurring a public hearing, or, if the current ase is to be honored, a public hearing should be required prior to allowing Atlas to implement any quarry activity. I contend that the issue of quarrying borrow material from Round Mountain remains unresolved.

Section 4.74.3 further mentions providing local residents 'compensation of some sort'. Such compensation is not defined, however. Since no public hearing has taken place, nor has been required, there has been no input from residents, property owners and others as to what would constitute proper compensation. As the nature of such compensation is not outlined or clearly defined in the current proposal (and cannot be without public input from residents and property owners), nor is an avenue of redress regarding the adequacy of compensation, if any is given, clearly outlined or defined, the issue of compensation remains unresolved. If, on the other hand, it is determined (somehow) that the Round Mountain will be used (regardless of public sentiment and aesthetic damage to the Valley) I suggest that the only acceptable compensation be restoring Round Mountain to its pre-operations original appearance when quarrying is complete. This would require saving and replacing surface stone that has the proper weathered patina; replacing vegetation, and otherwise assuring that the mountain is structurally and aesthetically sound and original.

Restoration of Round Mountain would no doubt be expensive, as would the additional cost of obtaining borrow material from other, more distant sources. Either option would add to the cost of the Atlas site proposal. Given additional costs, it may become more feasible to consider implementing the Plateau site proposal. As cost comparisons become more equal, it makes even more sense to go with the Plateau site, as it offers more geological, hydrological and environmental stability over time, bringing me back to my original points. Thank you for your attention to this response to the January, 1996 Draft Environmental Impact Statement Relating to Reclamation of the Uranium Mill Tailings at the Atlas Site, Moab, Utah, NUREG-1531.

Sincerely;

Rod M. Bradfield

United States Senate
WASHINGTON, DC 20510-1401
OFFICIAL BUSINESS

Richard G. Lugar U.S.S.

ACTION

EDO Principal Correspondence Control

FROM: DUE: 04/03/96 EDO CONTROL: GT96164
DOC DT: 03/07/96
FINAL REPLY:

Sen. Richard G. Lugar

TO:

Dennis Rathbun, OCA

FOR SIGNATURE OF : ** GRN ** CRC NO: 96-0249

Executive Director

DESC: ROUTING:

ENCLOSES LTR FROM ROD M. BRODFIELD RE URANIUM MILL TAILINGS

Taylor
Milhoan
Thompson
Blaha

DATE: 03/21/96

ASSIGNED TO: CONTACT:

NMSS ~~Paperiello~~

SPECIAL INSTRUCTIONS OR REMARKS:

Reply in duplicate & return incoming with reply.
Mark envelope ATTN:Darlee Williams.

DWM Action
Due to NMSS Director's Office
By 3/29/96
rec'd 3/22/96

Flegal

Mike, see me b4 you start to write Joe

ACTION: Holonich
Due to DWM
Director's Office: 3/28/96

cc: Federline
Weber

3/25
3/25 rcs

OFFICE OF THE SECRETARY
CORRESPONDENCE CONTROL TICKET

PAPER NUMBER: CRC-96-0249 LOGGING DATE: Mar 14 96

ACTION OFFICE: EDO

AUTHOR: SEN. RICHARD LUGAR
AFFILIATION: U.S. SENATE

ADDRESSEE: DENNIS RATHBUN

LETTER DATE: Mar 7 96 FILE CODE: MH&S 11 URAN. MILL.

SUBJECT: URANIUM MILL TAILING

ACTION: Signature of EDO

DISTRIBUTION:

SPECIAL HANDLING: OCA TO ACK

CONSTITUENT:

NOTES:

DATE DUE: Apr 4 96

SIGNATURE: DATE SIGNED:
AFFILIATION:

EDO -- GT96164

RICHARD G. LUGAR
INDIANA

306 HART SENATE OFFICE BUILDING
WASHINGTON, DC 20510
202-224-4814

United States Senate

WASHINGTON, DC 20510-1401

COMMITTEES:
AGRICULTURE, NUTRITION, AND FORESTRY
CHAIRMAN
FOREIGN RELATIONS
SELECT COMMITTEE
ON INTELLIGENCE

March 7, 1996

Mr. Dennis Rathbun
Office of Congressional Affairs
Nuclear Regulatory Commission
11555 Rockville Pike
Rockville, Maryland 20852

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Thank you for your thoughtful attention.

Sincerely,

Richard G. Lugar
United States Senator

RGL/dwl
enclosure

[redacted] 5-15-95

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Rod Bradfield
1201 South Center Street
Terre Haute, Indiana 47802

96 MAR -4 PM 3:02

January7,1978

Senator Richard Lugar
306 Senate Hart Office Building
Washington, D.C. 20510-1401

Dear Senator Lugar;

I am impressed with the effort put into the January, 1996 Draft Environmental Impact Statement Relating to Reclamation of the Uranium Mill Tailings at the Atlas Site, Moab, Utah, NUREG-1531. After reading the DEIS, I am writing to state my support for the alternative plan (moving the Atlas tailings to the Plateau Site), opposing the proposal to leave the Tailings at the Atlas Site.

Except for the issue of using Round Mountain in Castle Valley as a Borrow Site for caprock at the Atlas site, I approached the DEIS from as neutral a viewpoint as possible. However, in almost all comparisons of environmental impact between the Atlas Site verses the Plateau Site, the point is made that 'some' present or future impact will or could likely occur at the Atlas Site, while little or no present or future impact would occur at the Plateau Site, other than temporarily losing a few hundred acres of cattle grazing land. As a specific example of the differences between the Atlas site and the Plateau site, seismicity at the Atlas Site remains an unresolved issue. (no such seismic problem exists at the Plateau site). Section 4.2, pages 4-6 and 4-7 of the DEIS states:

> *"In summary, the draft TER (NER 1996) lists the following unresolved geologic issues related to the Atlas site: "(1) capability of the Moab fault and its branches, (2) the nature of a buried scarp at the Atlas site, (3) the rate and nature of subsidence, (4) the effects of migrating sand dunes, (5) the effect of landslides emanating from Poison Spider Mesa, and (6) the seismic design basis."*

In another specific example, section 2.4.2, page 2-25, states:

> *"Tailings leachate seepage would continue to contribute small amounts of contaminates to the river, which, based on the analyses presented in Sections 4.4, 4.5, and 4.6, would not measurably or adversely effect water quality or aquatic biota beyond a small mixing zone. Under the Plateau site alternative, virtually no contaminates would enter area surface water once reclamation and ground water cleanup at the Atlas site are completed."*

Since the purpose of the Nuclear Regulatory Commission, as I understand it, is to manage thorough cleanup of contaminated sites in the best manner possible, it makes sense to use the Plateau Site. Cleanup would be more thorough and the Plateau site is seismically more stable and far from the Colorado River with its potential flood and leachate problems. The DEIS offers several projections of leaching and break down of the Atlas site in flood, earthquake or

landslide situations, stating that such leaks or breakdown would pose only a minimal threat to the environment. Again, when an alternative disposal site is available that all but eliminates such threats, being geologically and hydrologically more stable over a longer period of time, it behooves the parties involved to use the alternative site. Cost considerations, while important, should be secondary to preventing even minimal environmental impact.

Regarding costs, I note that the Plateau site alternative proposal would use the existing railroad between the Atlas site and Plateau site, running alongside U.S. highway 191, for transport of material from Atlas to the Plateau site. In the Atlas plan, a rail spur of approximately 3.3 miles would then be constructed at the Plateau end of the railroad to complete a rail journey to the Plateau site. Figure 2.2-1, page 2-15 of the DEIS shows a road already in place that could possibly handle truck hauling from the railroad to the Plateau site, 3.3 miles away. Using trucks from the end of the current railroad to the Plateau site could eliminate the need for an additional rail spur, perhaps cutting the cost of the Plateau proposal considerably.

The above examples discuss overall concerns regarding which available alternative would be the best all around solution. On a more personal level, however, I am most concerned with, and in opposition to, the lease by the Atlas Corporation at Round Mountain in Castle Valley, Utah, to obtain igneous rock for use as capstone on the Atlas site proposal. As a property owner in Castle Valley who purchased the property primarily for its remarkable and pristine view, with plans to be a resident after retirement (10 years plus), I am extremely concerned about the aesthetic effects of the Atlas lease on the Valley.

The view from within Castle Valley is outstanding. From our lot, the La Sal Mountains to the southeast can be seen through the subtle haze of distance. Round Mountain, while smaller, is closer and more clearly defined. On closer inspection, Round Mountain, a darker, volcanic intrusion in the midst of lighter sandstone strata, is unique in the area (Atlas chose this site for borrow material because sandstone is not suitable, and few igneous or metamorphic sites exist in the area). The volcanic rock of Round Mountain contrasts dramatically against the tree covered La Sals; sparsely vegetated red sandstones of Castle Butte, Priest and Nuns spires and buttes forming the northern edge of the Valley; the variegated, medium brown sandstones of Porcupine Rim, running the entire length of the southwest edge of the valley); and the red, sandy valley floor, dotted more frequently with Pinyon and Juniper as the valley gently rises toward the La Sals. Such contrasts give Castle Valley its highly unique aesthetic quality. This uniqueness makes it a most desirable location to visit and live in, attracting property buyers, tourists, film makers and others.

True preservation of the unique beauty of Castle Valley can only be accomplished by careful planning right from the beginning of settlement. The Castle Valley Property Owners Association, recognizing the need for such preservation has developed guidelines for property owners to maintain the unique quality of the valley as more homes are built. The same must hold true for any use of state and federal lands, when pressures build to utilize them for mineral or rock extraction or other purposes. Extreme care must be exercised to assure that aesthetics (as well as ecology) are not compromised.

In the West, as elsewhere, property values are influenced by the available view, as well as by closeness of neighbors, industrial, commercial and mining development, and total population. At present, Castle Valley is somewhat regulated in terms of lot size, industrial / commercial development and other intrusive activities such as mining or quarrying. This has been done to balance growth in such a way as to preserve the Valley's beauty. Visible scarring from quarrying operations by Atlas would inevitably effect property values.

While Round Mountain itself is state land, it nevertheless falls within the 'view' of residents of Castle Valley and travelers along the La Sal Mountain Loop Road and atop Porcupine Rim. This encompasses more than the southeastern view of Round Mountain from the residential portion of the Valley. Along the La Sal Mountain Loop road, numerous other views of Castle Valley occur, providing a clearer picture of the Valley as a whole, and a nearly complete (360°) view of Round Mountain. Outstanding views from Porcupine Rim, a mostly 4-wheel drive area, completes the circumference view of the mountain. La Sal Mountain Loop Road, and to a lesser degree, Porcupine Rim are used by numerous tourists in the area, with the Loop Road touted in most Moab tourist literature. The borrow operations proposed by Atlas could not avoid damaging such an extensive, all around view of the mountain.

Damage to the aesthetics of Castle Valley is mentioned in Section 4.7.4.3 of the DEIS:

> ***"The riprap operations proposed for Round Mountain would likely have substantial negative aesthetic effects on residents of Castle Valley and on visitors to the area. Post reclamation, the borrow activities would create scars that would likely take tens of years to weather and revegetate sufficiently not to bear strong indications of the operations."***

The above paragraph, with its use of the word 'substantial', is a strong statement regarding environmental consequences of quarrying borrow rock from Round Mountain, yet, to my knowledge, no public hearings have been held regarding this plan. Minutes and accompanying information from the Castle Valley Property Owners Association 1995 Annual POA Meeting state that the Atlas company went to the State Land Board to obtain a lease to mine 'building stone' from Round Mountain, instead of a lease for borrow material. Apparently, a lease for 'building stone' does not require a public hearing (a public hearing would have brought up objections and difficulties Castle Valley residents and property owners have with the Round Mountain proposal). I believe that such public discussion would have had a negative effect on granting a lease for taking any material from Round Mountain, stopping the plan before its inclusion in the DEIS. Since there was no public hearing, however, residents and property owners have had no say in the granting of the lease at Round Mountain, even though, as the DEIS clearly points out, long term negative aesthetic impact will be the result. Castle Valley residents and property owners have had no say in this aspect of the future of their Valley.

It is patently unfair, if not suspect, therefore, of Atlas to request a lease type which does not require public input from residents, property owners and others involved. Given the 'substantial negative aesthetic effects' on Castle Valley, it is paramount to determine public sentiment regarding present and future negative impacts of any proposed quarrying operation. The Atlas company should be required either to obtain a lease for the actual purposes it intends

se Round Mountain for (borrow material), thus incurring a public hearing, or, if the current ase is to be honored, a public hearing should be required prior to allowing Atlas to implement any quarry activity. I contend that the issue of quarrying borrow material from Round Mountain remains unresolved.

Section 4.74.3 further mentions providing local residents 'compensation of some sort'. Such compensation is not defined, however. Since no public hearing has taken place, nor has been required, there has been no input from residents, property owners and others as to what would constitute proper compensation. As the nature of such compensation is not outlined or clearly defined in the current proposal (and cannot be without public input from residents and property owners), nor is an avenue of redress regarding the adequacy of compensation, if any is given, clearly outlined or defined, the issue of compensation remains unresolved. If, on the other hand, it is determined (somehow) that the Round Mountain will be used (regardless of public sentiment and aesthetic damage to the Valley) I suggest that the only acceptable compensation be restoring Round Mountain to its pre-operations original appearance when quarrying is complete. This would require saving and replacing surface stone that has the proper weathered patina; replacing vegetation, and otherwise assuring that the mountain is structurally and aesthetically sound and original.

Restoration of Round Mountain would no doubt be expensive, as would the additional cost of obtaining borrow material from other, more distant sources. Either option would add to the cost of the Atlas site proposal. Given additional costs, it may become more feasible to consider implementing the Plateau site proposal. As cost comparisons become more equal, it makes even more sense to go with the Plateau site, as it offers more geological, hydrological and environmental stability over time, bringing me back to my original points. Thank you for your attention to this response to the January, 1996 Draft Environmental Impact Statement Relating to Reclamation of the Uranium Mill Tailings at the Atlas Site, Moab, Utah, NUREG-1531.

Sincerely;

Rod M. Bradfield

November 20, 1996

MEMORANDUM TO: Joseph J. Holonich, Chief
Uranium Recovery Branch
Division of Waste Management, NMSS

FROM: John W. Hickey, Chief [Original signed by]
Low-Level Waste and Decommissioning
Projects Branch
Division of Waste Management, NMSS

SUBJECT: REVIEW OF ANNUAL SURETY UPDATE SUBMITTED BY ATLAS CORPORATION FOR THE MOAB MILL, SOURCE MATERIAL LICENSE #SUA-917

We have reviewed the financial assurance information submitted by Atlas Corporation for the Moab Mill in correspondence dated August 27, 1996. Atlas asserts that decommissioning expenditures taken this year at the site more than offset increases based on inflation. Consequently, Atlas maintains that its financial assurance requirement is less than its Acstar Insurance Company performance bond for $6,500,000 currently held by NRC. Atlas proposes to maintain this bond in its current amount of $6,500,000.

Atlas claims that increases to the current surety based on inflation from June 1994 to June 1996, (approximately 3 per cent each year, or approximately $400,000), are offset by over $1,600,000 in applied decommissioning expenditures at the site. As you know, Atlas states that it has spent $1,659,718 on decommissioning work during the previous year. It is our understanding that your staff is familiar with the decommissioning expenditures referenced by Atlas for which they have taken "credit," and with the work performed in regard to these expenditures. We agree that the adjustments for inflation as proposed by Atlas are correct.

Based on this information, the $6,500,000 surety currently in place adequately responds to the current financial assurance requirements for the Moab Mill. Therefore, we agree that the current bond provided by Atlas and held by NRC is acceptable at this time.

Docket No. 40-3453
License No. SUA-917

CONTACT: Richard Turtil, DWM/NMSS
415-6721

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UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555-0001

November 20, 1996

MEMORANDUM TO: Joseph J. Holonich, Chief
Uranium Recovery Branch
Division of Waste Management, NMSS

FROM: John W. Hickey, Chief
Low-Level Waste and Decommissioning
Projects Branch
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Division of Waste Management, NMSS

FROM: John W Hickey, Chief [Original signed by]
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Projects Branch
Division of Waste Management, NMSS

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CONTACT: Richard Turtil, DWM/NMSS
415-6721

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MEMORANDUM TO: Joseph J. Holonich, Chief
Uranium Recovery Branch
Division of Waste Management, NMSS

FROM: John W. Hickey, Chief
Low-Level Waste and Decommissioning Projects Branch
Division of Waste Management, NMSS

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UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555-0001

Lee Rpt.

March 7, 1997

NOTE TO: File

FROM: Myron Fliegel, Senior Project Manager
Uranium Recovery Branch, DWM

SUBJECT: COMMENTS RECEIVED ON ATLAS DRAFT TECHNICAL EVALUATION REPORT

Attached are the comments received on the Atlas Draft Technical Evaluation Report (DTER), NUREG-1532, published January 1997. The DTER was published concurrently with the Atlas Draft Environmental Impact Statement (DEIS), NUREG-1531. Comment letters received on either or both of the documents were numbered in the order received. Within each letter, individual comments were identified and numbered. Comments directed to the DTER are addressed in the Final Technical Evaluation Report, March 1997. Comments directed to the DEIS will be addressed in the Final Environmental Impact Statement. The attached package of comment letters includes only those directed to the DTER.

Docket No. 40-3453
Source Material License No. SUA-917

Encl: DTER comment letters

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3018 Old City Park Road
Moab, Utah 84532
March 25, 1996

Joseph J. Holonich
Chief, High-Level Waste and Uranium Recovery Projects Branch
Division of Waste Management
Office of Nuclear Material Safety and Safeguards
Mail Stop TWFN 7J-9
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

RE: Comments on NUREG-1532, Draft Technical Evaluation Report for the Proposed Revised Reclamation Plan for the Atlas Corporation Moab Mill
Source Material License No. SUA 917
Docket No. 40-3453

The technical competence displayed in the DTER, NUREG-1532, is overall of a high quality and is, in my view, superior to that displayed in the Draft Environmental Impact Statement (DEIS), NUREG-1531, which I will comment on separately The technical competence in NUREG-1532 is not consistent from section to section, which probably reflects different staff's experience and the adequacy of the source material they were working with. I will review the sections in order:

Section 1.0
INTRODUCTION

This section is an accurate summary of information. Finally, in 1.2.3, we have a resolution between the figures 9.5 million and 10.5 million tons as the wet weight of the tailings; the former figure turns out to be <u>metric</u> and the latter English tons. The Moab public has suffered considerable confusion in the past two years by encountering one figure or the other in various documents, without the 9.5 million tons being labeled as a metric measurement.

Section 2.0
GEOLOGIC STABILITY

This section is very informative and up-to-date in respect to the literature, including results of the Utah Geological Survey of the Moab Quadrangle and the Lawrence Livermore National Laboratories review of seismic issues at all UMTRCA Title II sites completed in 1995.

We agree with the staff's determination of which issues are "open" and which are not of concern at the site (e.g., 2.4.2.3 volcanic ash; 2.4.2.4. potash mining; and 2.4.2.5 oil and gas).

An issue which needs to be addressed is that of interaction between the subsurface characteristics of the tailings impoundment and a seismic event's ground acceleration. The Utah Geological

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Survey (UGS) and the DTER agree that [illegible] depths under part of the pile, and is not encountered at all under the [illegible] DTER does not encompass the UGS field survey cross-sectional information presented [illegible] concerning the geology of the tailings site. What the UGS displayed on its [illegible] drawings was that the majority of the Spanish Valley salt collapse feature has a salt anticline (7000' thick under the pile according to the DTER; perhaps 12,000' according to Barnes) underneath sedimentary fill. Leaching of salts out of the top of the salt anticline by the flow of glacial water caused a soft sandstone to form out of the compressed non-soluble grains of sand in the Paradox Formation. Thus, in most of Spanish Valley, there is a layer of soft sandstone from 150 to 300 feet thick separating the glacial alluvium which contains fresh groundwater from the Paradox salts. The UGS did not find this rock layer consistently underlying the Atlas tailings site.

We therefore ask: How predictable and severe are the results of seismic movement, e.g., on the West Branch of the Moab Fault down the Colorado River, as interpreted through different geologic structures underlying different parts of the tailings pile? The specific issue here is: could the part of the tailings pile underlain only by wet alluvium and salt move differentially to the part of the pile underlain by drier, thinner alluvium and rock on top of the Paradox Formation? Could a seismic event accelerate subsidence or otherwise cause part of the pile to move differentially to the other parts and crack open the proposed cap? Do we have sufficient information given the very unusual geologic characteristics of the Atlas site to confidently assign probabilities to site deformation which could threaten cap integrity?

Section 3.0
GEOTECHNICAL STABILITY

The staff did a competent job of assessing the flaws in previous information, e.g., use of a seismic event in the Book Cliffs 50 km away to determine maximum ground acceleration at the Atlas site, and of identifying which issues are open and are resolved. Note comments on Section 6.0, below, concerning questions about the moisture content of the fines in the tailings, and the impact of moisture content values on liquefaction computations.

Section 4.0
SURFACE WATER HYDROLOGY AND EROSION PROTECTION

Selection of maximum rainfall, flooding, and erosion velocity figures seem correctly done. We agree that, on the Moab wash, it is the maximum flood event which poses greatest scouring, while the Colorado River at maximum flood will form a lake with little erosive action because the Portal is rock-bound and acts as a valve. The DTER seems to sidle around the issue of whether the Colorado River has in fact migrated towards the tailings pile in the last 40 years; aerial photographs taken over time in possession of Grand County clearly indicate to me that the river has moved by its entire width towards the tailings pile since 1954. This isn't difficult to believe, since the tailings are located on an outside bend of the river. From the changes shown in sand bars in the river over the 40-year period, I gather that the river has filled in its own channel by

sediment deposition from the south, and has moved north by a process of undercutting the north bank. The rock apron has been added to the design to resist erosion from a river migration reaching the toe of the tailings pile. I do not possess the engineering skills to judge the adequacy of the rock apron to stop this undercutting process when the river reaches the pile. Given its historic behavior, I'd bet on the river getting there within 200-1000 years, so the adequacy of this rock apron design to resist erosion is an essential issue. (2) TLJ

Re 4.5.1.2.2 on the Moab Wash: An average scour depth of 7-8 feet is cited. What is the standard deviation, or variability, of scour depth? If one does not wish to have a protective structure undermined, one needs to know the maximum depth of scour, it would seem. (A statistician is a person who drowns crossing a stream whose average depth is three feet.) (3) TLJ

Section 5.0
WATER RESOURCES PROTECTION

I would like to underscore for emphasis the staff's correct observations that geological structures and hydraulic conductivities under and in the area of the Atlas tailings pile show extremely high variability. Use of averages under such circumstances for any calculations or predictions is perilous.

Section 5.2.4, groundwater flow, presents estimates for hydraulic gradient and hydraulic diffusivity for the alluvium. In 5.4.3, the volume of leachate currently leaving the tailings into groundwater, and future trends in that leaching volume which are hoped for as the result of the "corrective action program," are again estimates. This entire water resources protection section is a structure which rests on estimates, rather than measurements, as the premises for the analysis. (4) MCL

It does appear to us that background well AMM-1 is influenced by leachate from the former ore storage pad situated about 61 meters west. Since Maximum Concentration Limits for leachate are either the EPA MCLs or a higher level if found in the background groundwater, using an ore-contaminated source automatically alters the leachate MCLs upwards (see Table 5-9). The NRC staff correctly identifies this as an open issue; we wonder how it could be resolved with confidence. (5) MCL

In 5.2.5, staff correctly observes that groundwater sampling downgradient from the tailings in the alluvial acquifer lacks "...consistency in the sampling points, constituents analyzed, and laboratory methods used." There are two other inconsistencies in data which will be presented to the staff by Atlas in hopes of closing open issues regarding groundwater corrective action. On March 19, 1996, Smith Environmental presented slides showing recent groundwater sampling results by quarter, intended to monitor the effect of the groundwater corrective action program at the site. The slides were overlain with a linear regression interpreting the progression of results from past to present as a steady decrease in the concentration of alpha radioactive material and natural uranium in the leachate. Having done doctoral work in statistics at UCLA, I noted two things about the bar graph presented on the slides, which would lend to a different interpretation than (6) MC

that given by Smith: first, there were one-time spikes and troughs in the analysis series which were as large in magnitude as the height of the bars which the regression line fit, second, it appeared to me that a step-function equation would account for more of the variation in the figures presented than a linear regression would. As to the first point: the spikes and troughs were explained by Smith as due to laboratory error. If the error term or variation in an analysis is as large in magnitude as the reported main effect, you cannot achieve statistical significance in a linear regression with a limited "N" as presented. As to the second point: disregarding the spikes and troughs, the remaining bars appeared to represent a higher plateau, which then dropped to a lower plateau on the right-hand side of the slide. Further, in reviewing my notes, I find that the alpha radiation level in the 1994-95 plateau shown on the slide resembles the levels observed in the 1988 analysis of leachate. I also find reports of NRC staff saying the level of radionucleides in the leachate went up radically circa 1990, and then came back down again consequent to the pumping of free water out of the tailings pile.

(6) MCL

(7) MCL It appears to me that Atlas cannot demonstrate a statistically significant decline trend in the concentration limits of radionucleides in the tailings leachate. Staff should statistically test a model which says, in effect: "leachate was at a steady level of concentration circa 1988, then went up to a high plateau, and has now come back down to the 1988 plateau and is continuing at that accustomed level and not declining significantly over time." The 1995 figures given by Smith for AMM-2 was 2040 pCi/l, AMM-3 was 2425 pCi/l, and AMM-2.5 was 2410 pCi/l, versus a MCL of 33 pCi/l. The 4th quarter of 1989 results were AMM-2 = 3400 pCi/l, AMM-3 = 2200, and "ATP-2S" (same well?) = 5600 pCi/l. The distortions in use of an average across three test wells is herein illustrated: two of the wells in 1989 showed higher, and one showed a lower gross alpha level than in 1995. Because of the change in nomenclature, it isn't clear if one of the wells is the same well in the two different samples.

(8) MCL It is also worthy of note that the extensive tables (e.g., 5-2, 5-3 and 5-4) presenting leachate analyses never present the gross alpha radioactive component of the leachate samples, which is consistently the fraction which most greatly exceeds the maximum concentration limit (always by one and sometimes by two orders of magnitude!). By ignoring the most deviant leachate component in groundwater sampling, the analysis gives the impression of pussy-footing around the significant issue: Is the Atlas tailings pile leaching enough radionucleides or heavy metals to affect the Colorado River system through bioaccumulation? Has it done so? Will it continue to do so?

(9) MCL This brings us to the question of the Colorado River water sample tables, 5-5, 5-6 and 5-7. The 1976-77 figures in Table 5-5 make some kind of sense, in that the figures for the river below the Atlas tailings are slightly higher than those above the tailings (U +20%, Ra-226 +11%, Th-230 +82%). The 1979 to 1987 figures defy common sense. The figure for natural uranium downstream of the pile is on average only 64% of the level above the pile, and the figure for Thorium-230 is 29% (71% lower) in the samples downstream of the pile than upstream. We are either looking at variance due to laboratory and/or sampling variables and thus data in which differences are due to chance, or we are witnessing radioactive materials happily scampering out

of the river so they can have a party under the pile with their kinfolk. Maybe they were migrating into the pile to breed, and the progeny accounts for the peak in leachate radionucleide concentrations circa 1990... If we are not to embrace this sort of whimsical radionucleide animism as the explanatory hypothesis for this data, we need to admit that this data is obviously junk - an artifact of sampling site location, laboratory error, or both.

The wide variation in data suggests that a clear understanding of laboratory margin of error should be established before further using any of this data as if it had known statistical reliability. On the face of it, one can make a case that there are no reliable findings; only artifacts or "noise" due to sampling and laboratory variability.

Common sense also suggests that the leachate impact on the Colorado River system would not appear in free samples of water, because of the huge volume of river water relative to the leachate. It would appear in bioaccumulation due to chemical capture of heavy metals, radioactive or not, through interaction with organic materials in sediment (which is how uranium ores were produced in the first place), and through increasing concentration in the river food chain.

This brings us to the WestWater Engineering study, which was supposed to carry out the study designed by the National Park Service to address precisely these biomediated impacts. The DTER makes no mention I can find of this study The Park Service review of the study indicated that, because the number of samples drawn per seven sites was one rather than three, and the samples were taken at high water when the actual sample sites selected by the Park Service could not be reached, the screwy results were scientifically inconclusive. However, to the extent any interpretable findings are present, they suggest to me that significant bioaccumulation may be taking place.

Because the data on leachate and free-water concentrations of leachate from the tailings pile are so "noisy" and questionable; because these concentrations are of academic interest anyway if there is no cumulative impact on the Colorado River system from them; and because the study of river bioaccumulation produced provocative but inconclusive results; I submit that groundwater impact issues **cannot be closed until and unless the National Park Service study of bioaccumulation in the Colorado River is performed to achieve statistically/scientifically reliable results**. This "open" issue cannot be closed without reliable bioaccumulation study results.

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Section 6.0
RADON ATTENTUATION

6.2.1, characterization of the tailings, appears to say that the analysis of fine and coarse tailings in the pile, including moisture content, was prepared by taking test borings limited to "depths up to 8 feet," whereas the pile is 110 feet deep. Further, boring samples were combined into composites before analysis. This hardly seems adequate to understand the characteristics of the fine tailings, particularly their moisture content, through the various horizons of the pile. I

10 ES

10 understand that this section is primarily concerned with the content of materials near the surface of the tailings impoundment that bear on radon attenuation capacities of the radon barrier. However, I cannot find a more appropriate place in the DTER to comment on this issue.

11 The DTER notes that analysis of coarse tailings for Ra-226 was composited over various depths of bore, which is an appropriate procedure only if it is known that the tailings are homogeneous at various depths; since this isn't known, the Ra-226 composition is an open issue.

12 **The moisture content values for the coarse tailings cited in 6.2.2 appear consistent with what contractors actually encountered when moving Title I piles. However, the moisture content values expressed for the fine tailings in Table 6-1 are far below actual moisture content values reportedly encountered in the fines of Title I piles. The moisture content of the fines would seemingly have a major bearing on liquefaction calculations.**

13 In 6.2.3, the diffusion coefficient values used by Atlas for the Klondike Flats clay are questioned. Moisture content for the clay used by Atlas seems typical for the area. However, elsewhere I read that the exact borrow site for the clay has not been identified. Therefore, it appears the clay radon barrier design proposed by Atlas rests on estimates of values subject to change upon realization of actual test values. Obviously, the clay barrier layer design can be modified to meet radon attenuation criteria. However, such modification, if towards a thicker clay layer to achieve diffusion criteria, will have an impact on the cost and upon the method of application to insure appropriate compaction, which is listed elsewhere as an issue with the existing design. I will pick up on this issue in the DEIS comments.

14 **I agree with staff conclusions in 6.4 that frost heave is not an issue regarding durability of the radon barrier. I am uncertain about the assumption that roots and burrowing animals are not an issue. The rock layers on the top and sides of the pile constitute both a mulch, and a trap for blowing soil. We are located in a high-altitude desert area where deep-rooted desert plants establish themselves in improbable places - take a tour of the slickrock benches by Courthouse Wash in Arches sometime to witness large trees and shrubs established in cracks in seemingly solid rock. Where there are roots running down (up to 30 feet), there are rodents pursuing the roots for lunch.**

Section 7.0
APPENDIX A ASSESSMENT

This section is the worst in the DTER. The overall impression I get is that the rest of the document was written by various technical specialists, while this section was written (or perhaps copied from the FONSI) by someone who did not have full command of the current technical material pesented by the staff in previous sections, and had one eye on political considerations. As I review below, time after time the analysis mis-represents the site characteristics relative to the Appendix A criteria. In each case, I submit the NRC's position is best served by frankly addressing the reality of site characteristics, and then stating why either (1) the in-place

configured. Also enclosed is a graph from our Grand [illegible] showing visitation to the National Parks. In 1994 we had 780,000 visitors to Arches (as counted at the Visitor's Center). In 1995 (not shown) visitation exceeded 800,000. 15 MHF

Criterion 1, Item 2: "The licensee is currently implementing a corrective action program (CAP) to return ground-water quality to established standards." *Per the critique in* Section 5.0 above, it seems very unlikely that the licensee can return ground-water quality to established standards. The "revision of the CAP on the basis of information collected since it was initiated" is very likely to represent proposal of Alternative Concentration Limits (ACLs). Hydrological and other natural conditions at the site work against continued immobilization and isolation of contaminants from ground water sources. The NRC should be forthcoming about this in their presentation on this item. If the NRC elects to approve the licensee proposal, frankly state it is because the tailings pre-existed adoption of 10 CFR 40, Appendix A, and the NRC elects to accept ACLs because it believes the mobilized and not-isolated contaminants in the tailings are not having and will not have an adverse impact on groundwater sufficient to justify disapproving the licensee's reclamation proposal. 16 MHF

Criterion 1, Item 3: As was the case with Criterion 1, Item 2, the site characteristics favor "erosion, disturbance, and dispersion by natural forces over the long-term." The NRCs actual stated case is that design features can overcome this site potential. 17 MHF

Criterion 1, Item 4: "The staff is unable to conclude that the site will not require active maintenance to mitigate the effects of geologic, including seismic, disturbances." Per discussion above, because of geologic characteristics peculiar to the Atlas site, technicians have to render opinions about the likelihood of disturbances which contain a large component of guesswork and a relatively small component of reliable geologic modeling. Any future statements about this item should recognize that there is a large margin of uncertainty in the estimation of the probability of site disturbance which would require active maintenance to repair. 18 MHF

Criterion 3: "...if the other criteria are met, the benefits over stabilizing the tailings in place would be negligible." "...the cost of disposing the contaminated materials below grade by relocating the disposal area would be much greater than the benefit realized, making relocation economically impracticable." This criterion discussion is admirably straightforward, and brings the basic issues into clear focus: can the "other criteria" be "met" given mitigation of site problems by design features, and would relocation actually cost that much more than in-situ reclamation? We have recently obtained cost analyses from DOE contractors which are far less than Atlas/Oak Ridge estimates for relocation. These will be discussed in the DEIS analysis submitted separately. 19 MHF

Criterion 4(a): "reqires that upstream rainfall catchment areas be minimized to decrease erosion potential and the size of the floods which could erode or wash out sections of the tailings disposal area." Once again, the NRC would be well-served to admit that the site itself, on the Moab Wash and Colorado River, does not minimize upstream catchment areas, and possesses significant erosion potential (the Moab Wash took out U.S. 191 three years ago in a flood, 1.3 miles 20 MH

reclamation plan is unacceptable because of the failure to meet the criterion, or (2) why the in-place reclamation plan is acceptable despite the site problems. Currently, many presentations come across as examples of bureaucratic reasoning out of a George Orwell novel about Newspeak ("war is peace"), and provoke the public impression that the NRC is enmeshed in some sort of bizarre alternate reality incapable of dealing credibly with issues of public health and safety at the Atlas site.

My impression of Section 7 is colored by the ludicrous statements in the evaluation of Criterion 1, Item 1, "Remoteness from populated areas." In essence, the item describes the population adjacent to the Atlas site as falling and continuing to fall, and puts the City of Moab 3 miles southeast of the site. Arches National Park is located "about two miles northwest."

First, please find enclosed the section The Potential Dimensions of Growth from the 3rd draft Grand County Comprehensive General Plan (the version which is currently in the public hearing process preceeding adoption). This contains the population projections for Grand County from the State of Utah Economic and Demographic Projections 1994. These official projections predict an increase in population of 134% from 1990 to 2020, with total employment increasing 188%.

Second, please find a reprint from the Canyon Country Zephyr of the results of the City of Moab survey of landowners in the strip from the current north boundary of the City to the Colorado River bridge along U.S. 191. Note the massive development of motels, campgrounds, restaurants, and shopping facilities projected. **Two of the largest proposed developments are currently active in getting the necessary permits and infrastructure to build what they propose (I serve on the Grand County Planning and Zoning Commission and am involved with the Capital Infrastructure Plan development). At this writing, the City of Moab is reconsidering the size of their sewer plant upgrade to accomodate this development, and would annex such commercial development into the City so the City can collect sales tax. Thus, by 2020, it is quite possible that the City of Moab's northern boundary will be located on the north end of the Moab Valley and RV Campark on the bank of the Colorado next to the U.S. 191 bridge, with a solid strip of visitor accomodations, outdoors and in, running on south. The entrance road into the Moab Valley and RV Campark is 1.3 miles on U.S. 191 from the entrance road from U.S. 191 into the Atlas Mill site. Line-of-sight distance from the toe of the tailings impoundment to the nearest existing campsite is slightly over one mile. Thus, within a time frame of approximately 30 years, the tailings impoundment will be 1.1 mile from a densely-inhabited area and the city limit of the City of Moab.**

Third, the Atlas Minerals fee-simple property on which the tailings cell is located directly abuts the U.S. 191 right-of-way, which in turn abuts the southern boundary of Arches National Park. The tailings impoundment area and Arches are actually circa 1200 feet apart at their closest points. The Arches National Park Visitor's Center is 1.3 road miles from the entrance to the Atlas Mill; the Arches housing complex for employees is on the Atlas side of the Visitor's Center, and appears to be 1.2 miles from the nearest edge of the tailings impoundment as currently

upstream from the tailings impoundment). The argument presented is then a straightforward response to this acknowledgement, maintaining that design features acceptably minimize erosion potential at the site (20) MHF

Criterion 4(b): "topographic features should provide good wind protection." The statement made here is bullshit. Anyone familiar with the site knows that the Moab Fault/Wash canyon and Spanish Valley line up across the Atlas site in the prevailing wind direction, so that the Atlas site is effectively located at the bottom of a wind tunnel. Again, it is the staff position that design features, namely the size of rock riprap, provide adequate protection against wind erosion of the tailings. As far as I can tell, the staff is right. (21) MHF

Criterion 4(c): Again, the discussion could be more straightforward about the obvious fact that the cover slopes are not relatively flat to minimize erosion potential. Instead, it is best to be frank about the fact that site limitations prevent flattening out the stabilization cover slopes to meet criteria, and that erosion is instead addressed through the design feature of relatively large rock used on the slopes to resist erosion. (22) MHF

Criterion 4(d): The discussion of this criterion is refreshingly candid about the fact that self-sustaining vegetative cover is not applicable to this arid site, and that the rock armor design is substituted to serve the same purpose (23) MHF

Criterion 4(e): The discussion is straightforward in identifying the question of a capable fault as an open issue. See Criterion 1, Item 4 discussion for analysis of uncertainty involved in information from the licensee or anybody else trying to close this issue. (24) MHF

Criteria 5, 7, and 13: concern groundwater protection. See my discussion under Criterion 1, Item 2.

Criterion 6: concerns standards for attentuation of radon emissions from the stabilized pile. The analysis is straighforward. I do take exception to the sanguine statement made about 6(7) re post-closure escape of nonradiological hazardous constituents. See the discussion of groundwater discharges in Section 5.0 above. (25) MHF

Criteria 9 and 10: concern financial surety to carry out the reclamation plan by the licensee. The problem I have with this topic is the chicken-and-egg confounding of using cost estimates in the DEIS to justify the capping-in-place plan, while virtually everybody including the licensee (on February 28) questions that the estimate of the cost of the capping-in-place plan is adequate to actually carry out the proposal in its current incarnation. (26) MHF

Criterion 12 is for my purposes the same as Criterion 1, Item 4; see those comments.

Sincerely yours,

Richard L. Christie

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Saxon Sharpe
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April 22, 1996

Joseph Holonich
Chief, High-Level Waste and Uranium Recovery Projects Branch
Division of Waste Management
Office of Nuclear Material Safety and Safeguards
Mail Stop TWFN 7J-9
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Dear Dr. Holonich;

The Draft Environmental Impact Statement Related to the Reclamation of the Uranium Mill Tailings at the Atlas Site, Moab, Utah (NUREG-1531) and the Draft Technical Evaluation Report for the Proposed Revised Reclamation Plan for the Atlas Corporation Moab Mill (NUREG-1532) do not adequately address the impact of climate variation. As a paleoecologist focusing on both short and long term climate change within the Colorado Plateau and Great Basin provinces, I suggest that this topic be added to the list of open issues. Although many of the unresolved issues listed in the technical report are of concern, my comments are limited to climate regimes affecting the reclamation plan. In short, climate fluctuation will affect the tailings pile. This opinion is based on published, peer-reviewed research on 1) shifts in climate regimes, and 2) the frequency and magnitude of past storm events on the Colorado Plateau.

First, NUREG-1532 (2.3.3.2 and 2.4.1.1) divides climate into two phases: "wetter" prior to 10 ka (10^3 years before present) and "drier" thereafter. It also assumes our climate will remain "dry". This oversimplifies complicated interactions between seasonal precipitation, seasonal temperature, storm trajectories, cloud cover, wind direction and velocity, and vegetation cover.

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and the reconfiguring of Moab Wash using rip rap to divert potential floods away from the tailings pile may not be adequate.

Migrating sand (NUREG-1532; 2.4.2.1) and wind erosion (NUREG-1532; 4.5.5) are mentioned in terms of how they may affect the site and not in terms of what they represent in terms of climate change. The nearby sand ramp is a relict of climate change, not just a potential hazard to the site. What the sand dunes mean in terms of climate change, source material, and wind direction should be addressed in the report.

5 PSJ

Past climate regimes and the frequency and magnitude of past storm events suggest that the following climate parameter estimates could be incorrect.

- The published historic maximum flood rates (NUREG-1532; 4.3.5.3) by Crippen and Bue, 1977, is a selective data set for a (geologically) short period of time. These records often cover a limited number of years and experience calibration problems with extremely high discharges.
- Estimated infiltration.
- Estimates of magnitude and concentration of rainfall.
- Moab Wash flow based on a one hour estimate of PMP of 7.4" and a 6 hour estimate of PMP of 9.36".
- Probable Maximum Flood (PMF) events (NUREG-1531; 4.3).
- Computer analysis based on 31 years of weather records to evaluate the effect of frost penetration (NUREG-1532; 3.3.4) and transportation of excess water to the frost line (NUREG-1532; 6.4).

Finally, short-sightedness in the specified "safety time frame" lead to three more sets of

9 MH

questions. The first concerns NUREG-1532 (2.1) stating that the disposal area be designed to control radioactive waste for a "reasonable assurance of 1,000 years" and a minimum of 200 years. The half-life of Ra-226, prevalent in the tailings (NUREG-1532; 6.0), is 1,622 years. Is a 200 to 1000 year minimum adequate? The second concern focuses on "contaminants...mostly settling to the bottom of Lake Powell" (NUREG-1531; 4.5.2.4). How many 200 year-old dams similar to Glen Canyon Dam exist in the world? Will Lake Powell exist 1,000 or even 200 years from now? Finally, NUREG-1531 (4.9.4) states "over the long term, a huge increase in (well water) withdrawal rates could eventually lower the water table sufficiently to cause residual tailing liquor at the tailings pile to migrate under the Colorado River and towards wells in Moab and Spanish Valley. However, no such cumulative impact would be expected because extensive use of the alluvial aquifer is not anticipated". Did Native American's living in the Moab area (see NUREG-1531; 3.7.6) 1,000 years ago "anticipate" the population, industry, tourism, and technology common in Moab today? 9 NH

Thank you for the opportunity to comment.

Sincerely,

Saxon Sharpe

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RICHARD E. BLUBAUGH
Vice President Environmental
and Governmental Affairs

April 29, 1996

Joseph J. Holonich, Chief
U.S. Nuclear Regulatory Commission
High-Level Waste and Uranium Projects Branch / Mail Stop: TWFN7-J9
Division of Waste Management / Office of Nuclear Material Safety and Safequards
Washington, DC 20555-0001

Re: License No. SUA-917, Docket No. 40-3453 -- Responses to Draft Environmental Impact Statement (DEIS)and Draft Technical Evaluation Report (DTER)

Dear Mr. Holonich:

Transmitted herewith are Atlas' responses to the DEIS and DTER noticed for public comment January 30, 1996 which pertain to the reclamation of Atlas' uranium tailings site near Moab, Utah. These responses have been prepared with assistance of counsel, Shaw Pittman Potts and Trowbridge. Due to the number and complexity of the comments, Atlas reserves the right to replace or to issue errata if minor revisions are deemed appropriate after further review.

What began as a "fast-track" NEPA process in March 1994 has become a rather lengthy and costly NEPA process. We are hopeful that your staff's review of the public comments, including our responses submitted herewith, will be as expeditious as possible. We are confident that your final decision in this matter will reflect the collective facts, information and expert opinion that has been brought to the forefront in this very exhaustive analysis. We look forward to receiving the record of decision as soon as possible so that we can begin the contractual process and subsequent implementation of the proposed reclamation plan.

We appreciate the opportunity to provide these responses. We trust they will be duly considered in the final analysis and decision. Please contact me at your convenience if you have any questions concerning the enclosed responses.

Sincerely,

Richard E. Blubaugh

Richard E. Blubaugh

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Finally, the DEIS assesses the impact of a hypothetical flood (HF) scenario in which 2.1 million tons of tailings are released into the Colorado River. The HF scenario combines two extreme assumptions: Pile failure is assumed to occur by "some arbitrary mechanism" other than the HF and the HF is assumed to occur concurrently. The HF combines the worst case conditions of all floods that could occur on the Colorado River. Maximum velocities are assumed coincident with maximum water levels to provide an upper-bound estimate of the ability of the river to erode and transport tailings. (p. 2-13)[205] Nonetheless, the DEIS concludes:

> At the Moab site, the hypothetical failure of the tailings pile design during an HF would have some temporary impact on water quality in the river near the pile. However, the river's water quality, which is already degraded regardless of the tailings pile, would be further degraded by only a slight amount. Contaminants from the tailings would be quickly diluted to currently existing levels, which are generally below water quality standards and criteria for the protection of aquatic biota. Thus, the long-term impact to water quality should be negligible. (p. 4-30 - 31).

Given that even under these extreme (i.e.. impossible) assumptions a failure after on-site reclamation would not produce significant adverse impacts and given that there is a "net detriment" to relocation of the tailings pile, it would be arbitrary, capricious and in direct conflict with the Mill Tailings Act, and national and international expert waste management criteria to relocate the pile.[206]

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[205] These maximum values (velocity and water level) cannot occur coincidentally in nature at the Atlas site since as water levels rise in the Moab flood plain (i.e., between the portals) velocities at the pile will decrease.

[206] NRC's HF scenario analysis is highly relevant as some public opinions have been expressed (particularly by NPS representatives) about the impacts of a tailings pile failure on the downstream river system and specifically Lake Powell. Mill tailings associated with the White Canyon uranium mill near Hite, Utah, currently reside beneath the waters of Lake Powell with no discernible adverse impact. Attachment M.

E. Summary

In summary, while the DEIS is basically a sound document, the FEIS should affirmatively conclude that the overall risks, both radiological and nonradiological (conventional) associated with the relocation alternative are greater than those for Atlas' on-site reclamation proposal, and that the costs of the relocation alternative are substantially greater such that when both risks and costs are considered, the relocation alternative results in a "net detriment" (i.e., does more harm than good) as a waste management intervention alternative.

IV. DRAFT TECHNICAL EVALUATION REPORT

A. Introduction

The background of Atlas' operations at Moab, and the regulatory framework and environmental concerns affecting final site reclamation have been discussed in some detail in the DEIS section of this response. Nonetheless, it is perhaps worthwhile to review and comment on the specific issues that triggered the current EIS, and the development of the attendant DTER. In this regard, it is also important to note that the DTER itself is focused solely and specifically on the Atlas application for on-site reclamation and not on the off-site alternative. While no comparison of alternatives is included or appropriate, it should be recognized that the information base the DTER utilizes regarding the on-site proposal is extensive and far greater than that which exists for the alternative. The data base for on-site reclamation is substantially complete.

At the time of the issuance of NRC's second FONSI,[207] public feedback indicated concerns with the process, including the perceived extent to which the EA review had been limited to only those aspects associated with the proposed license amendment. Some expressed concerns that critical elements of the situation at the Moab site had not been assessed in adequate technical depth, especially given the advance of technology and reclamation experience since the approval of Atlas' on-site reclamation plan in 1982. Concerns were expressed that the earlier EIS was superficial, that the past approval was hasty, and that unanswered technical issues exist that require further in-depth consideration.

In recognition of these concerns, NRC rescinded its FONSI[208] and issued a notice of intent to perform an EIS.[209] The key concerns that triggered this unprecedented retraction of a FONSI were summarized in the DTER (p. 1-4) as being:

- Major concerns related to seismic and fault evaluations;
- The potential effects of the Colorado River and its tributaries on the stability of the disposal cell; and
- The need for an updated, complete environmental assessment of the entire reclamation plan, including alternative disposal locations.

In a news release dated February 25, 1994, NRC expanded on these issues:

> "Major technical issues, identified in public comments, that require additional study and analysis include faulting and seismic analysis for the Moab site, and their potential impact on the long-term stability of the tailings, long term configuration of the Colorado River and its potential to encroach upon the tailings, and

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207/ 58 Fed. Reg. 38748 (July 20, 1993).

208/ 58 Fed. Reg. 52516 (October 8, 1993).

209/ 59 Fed. Reg. 14912 (March 30, 1994).

concentration limits for groundwater contamination present at the site."

The news release also noted that:

> "Major environmental analysis issues include the need for a more rigorous comparative cost and impact evaluation of the alternative of stabilization in place, versus relocation."

Thus, in revoking the FONSI and noticing an intent to prepare an EIS, NRC explicitly responded to public comments requesting additional expert assessment of the technical issues related to the site's stability and the potential for long-term impacts. These actions by NRC must be acknowledged as an extraordinary response to public sensitivities on these issues, particularly in light of the fact that the FONSI related to a single, narrow issue. That issue was a proposed amendment triggered by NRC's request to Atlas to *upgrade* the technical design components of its reclamation plan in accordance with NRC's new STP on surface stabilization. Since Atlas revised its reclamation plan to *upgrade* the stabilization design in accordance with the STP, it is not surprising that NRC issued the FONSI.

As noted above, the issues of concern are highly complex and highly technical. At a fundamental level, the questions posed by the public essentially relate to assessment of the long-term performance of both natural formations and engineered earthwork structures. The general uncertainty associated with such performance assessment questions has been the subject of many studies involving industry, academic and government experts over the years. Indeed, the continued reconsideration of methods to address technical performance standards reflects the results of efforts to ensure that reliable design analyses based on relevant assumptions and appropriate calculations are utilized in both the assessment and implementation phases of any

remedial action potentially affecting public health and safety. In this regard, it should be noted that to perform high quality assessments of the technical issues such as those noted above, and particularly in the depth requested by commentors on the FONSI, necessarily requires the involvement of highly qualified and, in some cases, highly specialized scientists and engineers.

In an effort to respond to the publicly expressed concerns and NRC requests for information, Atlas retained accredited nationally and internationally known experts in the required fields of science and engineering. To then question the involvement of such specialists in the process (as has been done) and to willfully ignore the results of the work performed by such experts, whether they be NRC's or Atlas', denigrates the experts and the process, and minimizes the significance of the issues raised. Some participants in the public debate who have raised technical issues have relied upon experts, albeit unidentified experts, to support their position, but unless and until those individuals reveal their experts' work product for public review, they cannot be considered "credible" on the issues addressed in the DTER.

The current revised Atlas reclamation plan and technical support documents under discussion by NRC in the DEIS and DTER are the result of a highly visible public regulatory process dictated by NRC regulations and policies. In fact, it should be noted that the process has been significantly more pro-active and open to public input than is the norm under current NRC practice and than is required by the regulations. A major example of this is provided by NRC's public issuance of the DTER for comment concurrent with its release of the DEIS. Normally, the DTER is a technical working document focusing on the licensee's compliance with technical regulatory criteria. Although a public document, it is not usually issued for public comment with

a DEIS. In this case, NRC has made an unusual exception and provided the draft DTER to the public so that NRC's comments and findings of the DEIS might be better understood, as well as to make the technical review fully visible to interested members of the public. Similarly, the record shows that Atlas has been extremely open in regularly sharing the results of its technical reports to NRC with an extensive mailing list, has voluntarily initiated various studies (e.g., the SENES Risk Assessment), and has sponsored its own public meeting to address any questions of concerned citizens of Moab.

Through this pro-active approach, a significant body of information has been developed for present or future reference on all issues associated with reclamation of the Atlas tailings pile. This information and database, as identified in the reference lists and contained in the referenced volumes, far exceeds the normal information base for many, if not most, similar performance assessment evaluations and provides the framework within which the DTER must be considered. In addition to the original technical investigations and analyses performed as part of the Atlas revised reclamation plan, Atlas has prepared and submitted to the NRC over 20 key initiatives and reports as part of the current EIS process since the FONSI was rescinded in October, 1993. The key technical reports prepared since 1993 are included as Appendices 1 through 18 to these comments.

The technical issues addressed and discussed in these and other reports include:

- regional and local faulting;
- seismicity potential - short- and long-term;
- subsidence potential (salt dissolution) differential and uniform;

- river meandering and flow erosion potential;
- storm and rainfall events and associated surface runoff;
- groundwater hydraulics and quality;
- surface water hydraulics and quality;
- mineral resources at both the existing and the alternate site;
- engineering design concepts for stabilization of the pile in accordance with NRC regulations and requirements including:
    - long-term slope stabilization and embankment protection
    - surface cover protection for erosion and sheet runoff
    - radon barrier and cover
    - channel designs for collection and discharge of surface runoff
    - channel designs for interception and diversion of area flows, particularly in Moab wash;
- screening level risk assessment of currently proposed and alternative reclamation plans including consideration of potential radiological and non-radiological occupational and public health impacts.

B. DTER Purpose and Framework

The DTER reviews Atlas' revised reclamation plan to determine whether it meets the criteria of 10 C.F.R. Part 40, Appendix A. As the DTER notes, these types of reports are "not normally available for public comment in most licensing cases. However, due to the extensive public interest and comment on the 1993 TER, NRC decided to make this draft TER available for public comment." (DTER, p. 1-1) Atlas, accordingly, addresses the issues raised by the DTER as part of its DEIS response.

As discussed above, the reclamation plan must provide *reasonable assurance* of complying with the technical criteria in Appendix A. The *reasonable assurance* standard is appropriate for the long time period of 1000 years covered by the criteria which requires analysis of long-term future performance, and precludes simple "as-built" tests for compliance.

Further, as discussed above, the individualized site-specific nature of each uranium mill must take into account the unique properties of each site and each proposed reclamation plan rather than establishing a standard plan or generic plan, particularly since many uranium mills were constructed long before current regulations were promulgated. Appendix A specifically recognizes and endorses flexibility for reclamation plans on a site-specific basis: "(i)n many cases, flexibility is provided in the criteria to allow achieving an optimum tailings disposal program on a site-specific basis." [210]

Several of the criteria in Appendix A are non-technical. Criteria 9 and 10 address financial issues. Criterion 11 addresses ownership issues. Criterion 12 addresses long-term surveillance of the site after reclamation by the license holder in perpetuity, required to be the federal or state government.

The remaining criteria are technical. Criteria 1-6 and 13 apply to the reclamation plan for an inactive uranium mill. The DTER of the revised Atlas reclamation plan addresses these technical criteria. Criteria 7 and 8 relate to operating uranium mills and are not applicable to the Atlas reclamation plan. All 20 open issues identified in the DTER are covered by Criteria 1-6 and 13.

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[210] 10 C.F.R. Part 40, Appendix A, Introduction.

C. Evaluation of the Technical Criteria of 10 C.F.R. Part 40, Appendix A by the DTER

1. Closed Issues

The DTER addresses all technical criteria required for a reclamation plan to comply with the regulations in 10 C.F.R. Part 40, Appendix A. The DTER is intended to be "a comprehensive assessment of Atlas' proposed reclamation plan" and is performed in a manner "to assure compliance with Appendix A (of 10 C.F.R. Part 40)." (DTER p. 1-5). The assessment was "performed in accordance with the Final Standard Review Plan for the Review and Remedial Action of Inactive Mill Tailings Sites under Title I of the Uranium Mill Tailings Radiation Control Act (UMTRCA), Revision 1 (NRC, 1993)." Although the Moab site is a Title II site, the applicable standards for Title I sites are similar, and NRC Division of Waste Management directs the staff to use this Standard Review Plan for Title II reviews.

Since the DTER is a "comprehensive assessment" addressing "compliance with Appendix A," any technical issues not raised in the DTER as "Open Issues" in the DTER are assumed to be closed and to reflect compliance with the reclamation requirements of Appendix A. It is understood that the reclamation plan must be implemented as written to assure compliance during implementation and that any major changes to the approved plan or its implementation would require review to ensure no additional "Open Issues" are raised. It is important to note that several of the listed "Open Issues" are procedural implementation issues requiring updates to plans, procedures, and specifications that can only ultimately be closed when the 12 remaining underlying technical issues are resolved.

It should be recognized that, the majority of technical issues encompassed by the criteria in 10 C.F.R. Part 40, Appendix A are considered closed by NRC. Furthermore, it should be stressed in this respect that of the two primary areas of public concern triggering the withdrawal of the FONSI (those being geotechnical questions about the pile's stability and hydrological concerns about the potential of the Colorado River and its tributaries to compromise the pile's stability), the latter had been completely resolved to NRC's satisfaction at the time of the technical review.

Of all the numerous technical issues that were reviewed in this process, the contents of the 120-page DTER contain only the 20 "Open Issues" listed on pages 1-5 to 1-7 that remain to be closed in order for the Atlas reclamation plan to fully comply with the technical requirements of 10 C.F.R. Part 40, Appendix A. Once these 20 open issues are resolved, the DTER indicates that the NRC staff can, on a technical basis, "support the issuance of a license amendment approving the proposed reclamation plan." Of the 20 "Open Issues," only 12 of the issues are technical issues concerning the suitability of the site and the reclamation plan to comply with the technical criteria. The other eight issues are procedural in nature and relate to documentation and implementation of the design. In this regard, it is important to note that the procedural issues begin with the assumption that the underlying technical suitability of the site and design reflects compliance, and that the procedural issues address only the technical implementation of the underlying design.

As noted in the DEIS discussion, preparation and development of the DTER has occurred concurrent with work being undertaken to address the technical issues under consideration. In

fact, as noted earlier, one of the "open" issues discussed in the DTER has been resolved to NRC's satisfaction between the time of the NRC publication of the DTER and this technical response (see the following table), and most are in the process of being resolved or believed capable of resolution in the immediate future.

Open Issue Status Update as of April 29, 1996

Item #	Description	Status
1.	Capability of Moab & West Branch Fault	S(A)
2.	Nature & Consequence of Buried Fault	S(F)
3.	Nature & Rate of Subsidence	S(F)
4.	Potential Affect of Sand Dune Migration	S(F)
5.	Landslide Hazard from Poison Spider Mesa	S(F)
6.	Additional Information on Seismic Design Basis	S(S)
7.	Additional Characterization of Tailings	P
8.	Disposal Cell Integrity in Seismic Event	S(S)
9.	Site Liquefaction Potential	S(S)
10.	Construction Specifications for Cover design	P
11.	Update Technical Specifications With Revised & Accepted Submissions	P
12.	Resolve Construction Specification for Cover Placement	P
13.	Revise Erosion Protection Plan	P
14.	Impact of Landslide on Erosion Protection	S(F)
15.	Site Groundwater Flow and Gradients	S(S)
16.	Use of AMM-1 as Background Monitoring Well	S(S)
17.	Use of Disposal Cell Design Features for Groundwater Protection	S(S)
18.	Sampling Plan for Ra-226 in Tailings	P
19.	Procedures for Ra-226 Characterization of "Affected" Soils	P
20.	Program for Testing Ra-226 in Clay	P

Legend:
S(A) - Submitted and Accepted
S(S) - Submitted and Believed Sufficient
S(F) - Submitted and Follow-up Verification in Process
P - Procedural Issues Pending NRC acceptance of Technical Issues

Note in addition to the above, three Confirmatory Items require incorporation of revised programs into the Reclamation Plan.

From Atlas' perspective, none of the open issues remaining at this time are of a material nature or incapable of appropriate resolution. Nonetheless, for the purpose of the subsequent discussion and for comparison to Appendix A criteria, the open issues at the time of the DTER's production are reproduced as indicated below:

- Technical Issues 1, 2, 3, 4, 5, 6, 8, 9, 14, 15, 16, and 17
  -- requiring resolution through additional scientific or engineering investigations.

- Procedural Issues 7, 10, 11, 12, 13, 18, 19, and 20
  -- requiring the submission of technical design specifications and field programs for ensuring compliance on implementation of the reclamation plan.

- Confirmatory Items 1, 2, and 3
  -- requiring the update of the Reclamation Plan to incorporate NRC accepted revisions.

The 12 technical open issues, eight procedural open issues, and three confirmatory items are listed in their entirety below, along with a summary of their status at this time.

2. Technical Open Issues

These issues are of primary technical importance to the resolution of the technical evaluation.

(1) Open Issue 1 -- Whether or not the Moab fault and the West Branch fault are capable faults.

Recent submission by Atlas' experts provide a comprehensive assessment of the capability of both the Moab fault and West Branch fault. Based on this information, NRC has stated (Telecon Record Mar. 27, 1996) it is satisfied the issue is resolved and that the Moab fault is not considered capable under NRC's definition. [Woodward-Clyde, 1/96]

(2) Open Issue 2 -- The nature and consequences of the buried fault or scarp beneath the southern edge of the tailings.

This issue is addressed by Atlas together with Open Issue 3. A recent submission by Atlas' experts provides a scientific analysis of subsidence at the site due to salt dissolution that addresses the affect of the buried fault or scarp beneath the site. Atlas believes this analysis, combined with the bounding calculation discussed in Open Issue 3 below, is sufficient to close this issue. [Woodward-Clyde, 1/96]

(3) Open Issue 3 -- The nature and rate of future subsidence at the site.

A recent submission by Atlas' experts provides a scientific analysis, using site data and conservative assumptions, that establishes the expected rate of subsidence at the site and evaluates the potential impact on the radon attenuation barrier. Atlas believes this analysis is sufficient to conclude that subsidence is not a concern for the reclamation plan design. [Woodward-Clyde, 1/96] In response to residual NRC staff concerns communicated through discussions with Atlas. Atlas is also performing a bounding calculation to determine the maximum degree of subsidence the radon attenuation cover design could withstand while still fulfilling its design requirements for 1000 years. Atlas believes this bounding calculation will show that the design can withstand more subsidence than could occur at the site. This bounding calculation will be submitted to NRC in the near future.

(4) Open Issue 4 -- Whether or not, or in what way, migrating sand dunes might adversely affect the stabilized tailings in the future.

A recent submission by Atlas' experts evaluates the potential for sand migration on to site design features using field investigations and engineering calculations. The analysis shows that, even with bounding calculations, the quantity of sand that could accumulate on site design features is very small. [Smith, 2/96] In response to residual NRC staff concerns communicated through discussions with Atlas, Atlas will conduct an additional field investigation and perform calculations to show that the maximum quantity of sand that could collect in the site drainage channels would be flushed away by runoff. Atlas believes that the submitted evaluation combined with the bounding analysis is sufficient to close this issue.

(5) Open Issue 5 -- Whether or not a potential landslide hazard exists from Poison Spider Mesa escarpment.

A recent submission by Atlas' experts reevaluates the landslide potential from Poison Spider Mesa adjacent to the Atlas site based on recent geologic mapping of the rock formations on Poison Spider Mesa, as well as an analysis of historic site data in light of the underlying factors associated with landslides. This analysis indicates that the potential for landsliding in the form of block slides or creep movement from Poison Spider Mesa adjacent to the Atlas site is low to non-existent. Atlas believes this evaluation is sufficient to resolve the potential for landslides adjacent to the site and close this issue.

(6) Open Issue 6 - The licensee has not provided sufficient information to evaluate the seismic design basis for the site.

Recent submissions by Atlas' experts provide comprehensive scientific information on the seismic potential for the Moab site based on extensive geologic and geophysical data. The comprehensive analysis establishes a peak horizontal ground acceleration of 0.18g for the Moab site. Atlas believes that the extensive analysis in this report is sufficient to establish the seismic design basis for the Moab site and close this issue. [Woodward-Clyde, 1/96]

(7) Open Issue 8 - The staff cannot conclude that the slopes of the disposal cell are designed to endure the effects of the geologic processes and events, including resistance to earthquake and settlement, to which they may reasonably be subjected during the design life and that the analyses have been made in a manner consistent with Chapter 2 of the SRP (NRC, 1993).

Previous calculations establish the integrity of the disposal cell design up to, at least, a peak horizontal ground acceleration of 0.25 g. (Canonie, 6/94, Appendix 5). Pending resolution of the seismic design basis for the Moab site (see Open Issue 6) at 0.25g or less, Atlas believes that the analysis submitted is sufficient to close this issue.

(8) Open Issue 9 - The licensee is currently reevaluating the liquefaction potential for the site. The staff's liquefaction analysis review has been suspended until the licensee's reevaluation is complete and the results are made available. Thus, the staff cannot conclude that there is adequate assurance of safety with respect to liquefaction damage.

A recent submission by Atlas' experts provides a probabilistic evaluation of the site liquefaction potential based on data on site seismic and flooding potential. The analysis indicates that the probability of occurrence is only one in 1,250,000 per year. Based on this analysis, Atlas concludes that liquefaction does not pose

a significant hazard to the tailings pile and believes the submission provides sufficient information to close the issue. [Woodward-Clyde, 1/96]

(9) Open Issue 14 - Consequences, with respect to erosion protection, of severe landslides have not been adequately addressed.

This issue concerns the impact on site design features from a potential landslide as discussed in Open Issue 5. Since Atlas believes there is no potential for landslides from Poison Spider Mesa adjacent to the tailings site (Open Issue 5), Atlas concludes that there will be no site impacts. Nonetheless, to address any residual concerns, Atlas has taken the conservative approach of designing the drainage channels adjacent to Poison Spider Mesa assuming 50 percent of the channel is blocked. Atlas believes that this design approach is sufficient to allay any residual concerns and to close this issue. [Smith, 3/96]

(10) Open Issue 15 - The licensee must provide additional data to support its interpretation of groundwater flow directions and gradients in the alluvial aquifer near the southern property boundary of the site.

A recent submission by Atlas' experts has reevaluated the groundwater flow direction and gradients on the southern part of the site based on additional water level information and reconsideration of the conductivity of the upland bedrock. The revised groundwater flow map is consistent with site groundwater flow directions and gradients proposed in the DTER. Atlas believes that this reevaluation and subsequent revision of the groundwater flow map in a manner consistent with the NRC position is sufficient to close this issue. [Smith, 2/96]

(11) Open Issue 16 - The licensee must provide data showing that monitoring well AMM-1 is not influenced by contaminants from the former ore storage pad.

A recent submission by Atlas' experts provides a detailed analysis and comparison of the monitoring results from AMM-1, the proposed site background well, with the other monitoring wells on the site. The continued consistency of results for AMM-1, independent of mill operations and ore storage pad use, compared with the variation of results from other site wells in step with mill operations, plus the fact that AMM-1 is upgradient of both the former ore storage pads and the tailings pile, demonstrate that AMM-1 is not influenced by contaminants from the former ore storage pad. Atlas believes this analysis is sufficient to close this issue. [Smith, 2/96]

(12) Open Issue 17 - The licensee must clarify whether it plans to take engineering credit for any disposal cell component for meeting compliance with the groundwater protection standards for the site. If engineering credit is taken, costs associated with achieving the necessary cover permeability must be incorporated into the reclamation plan.

A recent submission by Atlas' experts identifies how the reclamation plan design will be tailored to also provide groundwater protection as part of a synergistic surface and groundwater protection system. The aspects of the design that contribute to groundwater protection will be included in the revised reclamation plan. Atlas believes this submission is sufficient to close the technical aspects of the issue, and the procedural aspects will be closed when the reclamation plan is revised.

3. Procedural Open Issues

Underlying work is believed to be substantially complete and readily available for completion and closure of the following procedural issues, subject to NRC's acceptance of resolution of technical open issues, and subject to actual timing of implementation requirements. The procedural issue amendments were not formally incorporated into the suite of reclamation plan documents right away to avoid needless revisions on interim positions prior to final resolution of the issues. The entire affected suite of documents, including the Reclamation Plan, Technical Specifications, and field procedures, will be updated expeditiously following resolution of the technical open issues and subject to actual timing of the implementation requirements. The eight procedural open issues and the proposed resolution for each are listed below:

(1) Open Issue 7 - In order to complete the characterization of the tailings and the settlement analysis, the licensee needs to submit additional piezocone information. Prior to approval of the settlement evaluation, the licensee should submit a field exploration plan for the piezocone exploration program.

Atlas will include a field testing plan for piezocone testing in the comprehensive update to the Reclamation Plan.

(2) Open Issue 10 - The licensee should provide adequate, detailed construction specifications (or a quality assurance program) for field testing the moisture content of the radon barrier soils when lift placement is interrupted.

Atlas will include construction specifications for testing radon barrier material moisture content in a revision to the Technical Specifications for site construction.

(3) Open Issue 11 - Portions of the technical specifications have been superseded by later submittals, such as the revised cover design; however, the specifications have not been updated to reflect these revisions. The technical specifications need to be consistent with the reclamation design

Atlas will include these updates, including the revised cover design, in a revision to the Technical Specifications that will accompany the Reclamation Plan update.

(4) Open Issue 12 - The specifications permit the placement of fill in 18-inch-thick lifts; however, such lift thicknesses make uniform compaction difficult to achieve. The licensee should either specify more workable lift thicknesses or describe applicable procedures for verifying that thorough compaction has been achieved.

Atlas will include procedures for workable lift thicknesses to verify their uniform and thorough compaction in a revision to the Technical Specifications for site construction.

(5) Open Issue 13 - The licensee has not formally submitted revisions to erosion protection features that have been revised; consequently, inconsistencies with previous submittals exist. Additionally, details of layer thicknesses and gradation have not been provided.

Atlas will include the revised erosion protection features in the comprehensive update to the Reclamation Plan.

(6) Open Issue 18 - The licensee must provide a sampling plan for Ra-226 analysis of the upper 3 to 4 feet of coarse tailings and the technical basis for modeling the coarse tailings on the sideslopes as being homogeneous (i.e., a single layer) for Ra-226 concentration.

Atlas will include a sampling plan for the Ra-226 content of the upper 3-4 feet of tailings and the technical basis for modeling the tailings sideslopes in the comprehensive update to the Reclamation Plan.

(7) Open Issue 19 - The licensee must provide the gamma survey and sampling procedures for verification of tailings cleanup in the Moab Wash sandy soil borrow area for NRC approval. Also provide revised Reclamation Plan Specifications (Section 1.14 and 5.3.3) and page 40 of the text to indicate that the background soil Ra-226 value is the average value approved by NRC to demonstrate that the radon barrier will comply with Criterion 6 (5).

Atlas will provide a survey/sampling procedure for the borrow soils in Moab Wash plus appropriate revisions for soil Ra-226 background values in the comprehensive update to the Reclamation Plan.

(8) Open Issue 20 - The licensee must include in the testing program for the clay borrow material, analysis and/or gamma surveys to determine its Ra-226 value, to demonstrate that the radon barrier will comply with Criterion 6 (5).

Atlas will develop procedures to demonstrate that clay barrier materials contain background levels of Ra-226 and include them in the comprehensive update to the Reclamation Plan.

4. Confirmatory Items

In addition to the 8 procedural "Open Issues," there are three procedural "Confirmatory Items" which only require an update of the Reclamation Plan to incorporate revisions that have already been agreed to by the NRC and Atlas. Each of the "Open Issues" that requires a revision to the Reclamation Plan will, in effect, become a "Confirmatory Item" once the NRC and Atlas have reached an agreement on the issue. "Confirmatory Items" are closed out simply by revising the Reclamation Plan to include the agreed upon position. The three current "Confirmatory Items" and their status are listed below:

(1) Confirmatory Item 1 - Provide revised Reclamation Plan pages pertaining to the method of composite sampling for ore and tailings to accurately describe the sampling program.

Atlas will include the revised ore and tailings sampling program in the comprehensive update to the Reclamation Plan.

(2) Confirmatory Item 2 - Incorporate in the Reclamation Plan, the proposed testing program for "affected" soil to substantiate the radon flux model/calculation parameter values.

Atlas will include the "affected" soil testing program in the comprehensive update to the Reclamation Plan.

(3) Confirmatory Item 3 - Incorporate in the Reclamation Plan, the final clay borrow area proposed testing program to substantiate the radon flux model parameter values for the clay material.

Atlas will include the clay borrow materials testing program in the comprehensive update to the Reclamation Plan.

5. Comparison of Atlas' Reclamation Plan with Technical Criteria of 10 C.F.R. Part 40 Appendix A

The following sections go through the technical criteria of Appendix A and identify, broadly, what criterion and subissues have been closed, and then identify the remaining "Open Issues" in the DTER and the steps that have been taken to close these issues. To put the discussion in context, the following is a summary of all of the Appendix A criteria used by NRC in the DEIS assessment (Appendix C - DEIS). The list includes technical, financial, ownership, and long-term surveillance criteria (with each noted parenthetically).

SUMMARY LIST OF THE 13 CRITERIA IN 10 C.F.R. 40 APPENDIX A

1. Site Selection (Technical)

   (a) Maximize remoteness from populated areas.

   (b) Hydrologic and other natural conditions promote immobilization and isolation of contaminants.

   (c) The potential for erosion, disturbance, and dispersion by natural forces is minimal.

2. Avoid proliferation of small waste disposal sites. (Technical)

3. The prime option for disposal of tailings is placement below grade. (Technical)

4. Site and Design Criteria (Technical)

   (a) Upstream rainfall catchment areas are minimal.

   (b) Topographic features provide good wind protection.

   (c) Embankment and cover slopes must be relatively flat after final stabilization (generally not steeper than about 20% (1 vertical per 5 horizontal)).

(d) A vegetative cover or rock cover must be used to minimize wind and water erosion.

(e) The tailings are not located near a capable fault that could cause an earthquake larger than that which the impoundment could reasonably be expected to withstand.

(f) The impoundment design incorporates features to promote deposition of sediments and enhance the thickness of the tailings cover system.

5. Water Resource Protection (Technical)

(a) A design standard for tailings disposal is the primary groundwater protection standard imposed by EPA.

(b) Unless exempted, surface impoundments must have a liner.

(c) The impoundment must be designed to prevent overtopping.

(d) Impoundment dikes must be designed to prevent massive failure.

(e) Hazardous constituents entering the uppermost aquifer beyond the point of compliance must not exceed the secondary groundwater protection standard established by the NRC. NRC may exclude a constituent from the set of hazardous constituents on a site-specific basis if it finds that the constituent is not capable of posing a substantial present or potential hazard to human health or the environment.

(f) Alternate concentrations limits (ACLs) may be proposed by the licensee and established by NRC under certain conditions. Numerous factors are listed, which must be considered by NRC when establishing ACLs.

(g) If secondary groundwater protection standards established by NRC are exceeded, a corrective action program is required.

(h) Groundwater protection programs must consider the use of liners, appropriate mill process designs, dewatering of tailings, and neutralization of tailings.

(i) Actions must be taken to alleviate conditions leading to excessive seepage from tailings.

(j) The licensee must supply information on tailings composition, soil and geologic conditions, and use of groundwater at and near the site.

(k) Ore stockpiles must be designed to minimize movement of radionuclides into soils.

6. Radon Attenuation (Technical)

   Final reclamation of tailings shall provide reasonable assurance of control of radiological hazards for 1000 years to the extent practicable but, in any case, for at least 200 years, and limit releases of radon to an average of 20 pCi/m^2/s. After placement of the final cover but prior to placement of erosion protection barriers, testing and analysis or other method approved by the Commission shall verify that the radon limit is not being exceeded.

7. A preoperational monitoring program must be conducted at least one full year prior to any major site construction (Technical-operating sites).

8. Milling and tailings disposal operations must be conducted so that all airborne effluent releases are reduced to levels as low as is reasonably achievable. (Technical-operating sites)

9. Financial surety arrangements must be established. (Financial)

10. A minimum charge of $250,000 (1978 dollars) to cover the costs of long-term surveillance must be paid to the general treasury of the United States or other appropriate agency prior to license termination. (Financial)

11. Ownership of byproduct material and land must be transferred to an appropriate federal or state agency, which may permit certain uses of the land. (Ownership)

12. Site inspections must be conducted by the agency responsible for long-term care of the disposal site. (Long-term surveillance)

13. This criterion provides a list of hazardous constituents whose presence requires the establishment of secondary groundwater protection standards. (Technical)

The following sections address each of the technical criteria with respect to the Atlas Moab site reclamation plan.

a. Criterion 1 - Site Selection

The DTER does not raise any open issues for criterion 1. This criterion identifies general goals in siting and design decisions for "selecting among alternative sites or judging the adequacy of existing tailings sites." Several of the site features identified in the criterion relate specifically to selecting a new site from many alternatives. Criterion 1 provides that the new site

features include "remoteness from population areas," "hydrologic and other natural conditions as they contribute to continued immobilization and isolation of contaminants from groundwater sources," "potential for minimizing erosion, disturbance, and dispersion natural forces over the long term." These issues address the characteristics of a given site, independent of the actions of the licensee and, as such, are really decision criteria to be used as guidance in a comparative site selection process, rather than as regulatory criteria against which a single existing site can be evaluated for full compliance. This criterion is, therefore, more applicable to an EIS analysis, that compares alternatives, than it is to a TER, that evaluates the ability of a single site to comply with the technical regulations. The DEIS, and the materials provided by Atlas in this response and referenced supporting documents address these issues.

As overall guidance in making site and design decisions, the criterion puts forth the general concept that "primary emphasis must be given to . . . matter(s) having long-term impacts," as opposed to near term benefits "such as . . . transportation or land acquisitions costs." These issues are also more directly related to the selection of a new site.

Since Atlas' Moab facility is at an existing site, features for selecting a new site are not directly relevant to the site. It is further true that issues of site selection for a new site today are different from those features deemed important when the Moab site was selected by AEC 50 years ago and AEC directed placement of the tailings. The only issue in this criterion under an existing licensee's control is the requirement to dispose of tailings "in a manner that no active maintenance is required to preserve conditions at the site." The Atlas reclamation plan is designed to meet this requirement.

Open Issues

There are no open issues under Criterion 1.

b. Criterion 2 - Proliferation of Sites

The DTER does not raise any open issues for this criterion. In fact, NRC does not include Criterion 2 in the site assessment criteria listed in Section 7 of the DTER. This criterion identifies a general goal of "avoiding proliferation of small waste disposal sites and thereby [to] reduce perpetual surveillance obligations." The general goal of this criterion would appear to give a negative grade to alternatives that require the movement of materials away from an existing site and result in the creation of new sites. Reclamation at the Atlas Moab facility would not require the development of any new waste disposal sites, and therefore the proposed plan evaluated in the DTER complies with this criterion. In addition, this criterion is more relevant to the EIS which may consider alternatives that result in more that one tailings-related site. Note that even after relocation to the new site as discussed in the DEIS, the remaining Atlas Moab site likely would require years of active controls, including groundwater treatment, and site use restrictions.

2 MH

Open Issues

There are no open issues under Criterion 2.

c. **Criterion 3 - Below Grade Disposal**

The DTER does not raise any open issues under this criterion. This criterion establishes that for new sites, the "'prime option' for disposal of tailings is placement below grade, either in mines or specially excavated pits." Licensees must give "serious consideration" to this design approach in the "evaluation of alternative sites and disposal methods." This criterion is not applicable to an evaluation of in-place reclamation at the Atlas Moab facility, where the design for the existing pile was selected and established over 40 years ago. Interestingly, the criterion does state that "below grade disposal may not be the most environmentally sound approach . . . (where) a ground-water formation is relatively close to the surface." Thus the Atlas Moab facility is consistent with this guidance.

The only portion of this criterion applicable to an existing tailings facility is the requirement that "where full below grade burial is not practicable, . . . (i)t must be demonstrated that an above grade disposal program will provide reasonably equivalent isolation of the tailings from natural erosion forces." Natural erosion of the proposed Atlas Moab tailings cover design is addressed in the DTER (section 4.5) The evaluation concludes that "the erosion protection design appears to be adequate to provide reasonable assurance of protection for 1000 years, as required in Criterion 6 of 10 C.F.R. Part 40, Appendix A." (DTER p. 4-25) The Atlas Moab facility reclamation plan is therefore consistent with the applicable sections of this criterion.

(3) MH

Open Issues

There are no open issues under Criterion 3.

d. **Criterion 4 -- Site and Design Criteria**

Criterion 4 provides the geologic, geotechnical, and hydrologic and wind erosional standards for selection of a site and the design for tailings reclamation. The DTER identifies no remaining open issues for the erosion protection requirements of Criterion 4. The Atlas reclamation plan uses a conservative design of drainage channels and an extensive riprap layer to satisfy all water erosion criteria. Atlas uses conservative assumptions for the analysis in establishing the design basis flood and water velocity, and selects riprap sizes even larger than the analysis requires to assure the erosion protection of the site will satisfy the longevity requirements. The DTER agrees that Atlas "has identified the appropriate floods . . , water surface profiles and channel velocities . . . for the design of erosion protection features." (DTER p. 4-25) NRC concludes that "the erosion protection design appears to be adequate to provide reasonable assurance of protection for 1000 years, as required in Criterion 6 of 10 C.F.R. 40, Appendix A." (DTER p. 4-25) The reclamation plan and related implementation documents (e.g., technical specifications for construction) must be updated to match the design approved in the DTER.

Originally there was some question as to whether the Colorado River or the Moab Wash could meander over time to the toe of the tailings pile and potentially erode the pile. While analyses by Atlas show that it is very unlikely that either the River or the Wash would migrate to the tailings pile, Atlas has taken the very conservative approach of assuming that they both will do so and has designed the erosion protection to meet this highly unlikely scenario.

The seismic design basis for the Atlas site is clearly established by the recent comprehensive submittal from Woodward-Clyde Federal Services.[211] The report uses state of the art scientific techniques to provide the technical support to close not only the seismic design basis issue, but also the Moab fault capability issue, site subsidence issues, and the site liquefaction issue. Specific conclusions of the report are given below in the responses to technical Open Issues 1, 2, 3, 6, 8, and 9.

The potential impacts of surface rock movement, including sand migration and landslides, on the reclamation plan design are dispelled by the recent submittal from Atlas' experts (Smith Environmental Technologies).[212] While additional field investigations and analyses will be performed to verify the results, the report provides the analytical bases to close the issues of sand migration and landslides adjacent to the site possibly undermining the ability of site drainage channels to perform their required functions. Specific conclusions of the report are given below in the responses to technical Open Issues 4, 5, and 14.

The DTER also raises five procedural/implementation open issues related to site and design criteria. All of the issues relate to the development of plans, procedures, and specifications for the implementation of the reclamation plan. None of these issues challenge the technical suitability of the Atlas site or the reclamation plan design.

211/ Woodward-Clyde Federal Services, "Evaluation of Potential Seismic and Salt Dissolution Hazards at the Atlas Uranium Mill Tailings Site, Moab, Utah", January 1996. (Appendix 18).

212/ Smith Environmental Technologies Corporation, "Response to NRC Open Issues: Atlas Corporation Reclamation Plan Uranium Mill and Tailings Disposal Area", 88-067-33, March 1996. (Appendix 17).

The site and design comply with all wind erosion criteria. The site is "located in an area that provides some wind protection due to the local topography," consistent with Criterion 4(b). (DTER p. 4-25) Based on studies for NRC, the DTER concludes that "an engineered riprap layer designed to protect against water erosion (as the Atlas reclamation plan design is) will be capable of providing adequate protection against wind erosion." (DTER p. 4-25)

Criterion 4(e) establishes site seismic design requirements which couple the geologic site standard and the geotechnical design standard by requiring that the reclamation site "not be located near a capable fault that could cause a maximum credible earthquake larger than that which the impoundment could reasonably be expected to withstand." Thus the standard allows the geotechnical design to be tailored to site specific geologic stability so long as the two combined can be "reasonably be expected" to assure the stability of the tailings pile as required for the 200-1000 year design period in Criterion 6.

The DTER identifies nine technical open issues regarding the geological and geotechnical aspects of the site and design. These issues remained open at the time the DTER was released primarily due to a lack of information on seismic and surface rock movement issues. This information deficit has been addressed by the development and submittal of two significant technical reports by Atlas' experts since the DTER was released. While most of the nine issues have been closed or will be closed with the information in the new submittals, Atlas continues to work with the NRC to address any unresolved concerns on these issues.

(i) Technical Open Issues

The DTER identifies nine technical open issues for the site and design criteria of the reclamation plan. Of the major issues addressed by Criterion 4 (erosion and geological/geotechnical) only geological/geotechnical issues are identified as open issues. No surface water (Colorado River) or wind erosion issues remain open. The geological/geotechnical open issues can be combined into three groups: Seismic (open issues 1, 6, 8, and 9); Subsidence (open issues 2 and 3); and Surface Rock Movement (open issues 4, 5, and 14).

(a) Seismic (Open Issues 1, 6, 8, and 9)

Open Issues 1 (capable fault) and 6 (seismic design basis) define the seismic potential for the site in terms of maximum peak horizontal ground acceleration. The remaining two issues, Open Issues 8 (slope resistance to seismic event) and 9 (potential for pile liquefaction) are calculational evaluations of the proposed reclamation design that use the site seismic potential as input. Once the seismic potential for the site is agreed upon, the other two open issues can readily be closed by performing the analysis.

- **Open Issue 1**

"Whether or not the Moab fault and the West Branch fault are capable faults." (DTER p. 1-5)

Response:

The Moab fault and the West Branch fault have been determined not to be capable faults based on an extensive study by Woodward-Clyde Federal Services that was submitted to the

NRC in response to the DTER in February 1996.[213] NRC staff has concurred that "based on the information provided by Atlas in its response and other information, NRC is satisfied that (capability of the Moab and West Branch faults) is resolved."[214]

Based on all the geologic and geophysical data from this and previous studies, Atlas believes there is strong evidence that even though the Moab fault probably does extend beneath the tip of the northeasternmost corner of the Atlas uranium mill tailings site (Figure 2-18 of Appendix 18), the Moab fault is not a capable structure and does not pose a significant earthquake threat to the pile. To summarize in regard to Section III(g) of Appendix A of 10 C.F.R. Part 100:

1. Evidence strongly suggests that movement on the Moab fault has not occurred during the past 35,000 years and repeated movement has not occurred during the past 500,000 years;

2. There is no evidence for any historical macroseismicity on the Moab fault, and indeed, even microseismicity studies of the area reveal no earthquakes that were definitely associated with the Moab fault;

3. Based on recent mapping and structural evidence, faults within the northeast and southwest valley-margin deformation belts are most likely related to salt-dissolution collapse and are not structurally related to the Moab fault;

4. The Tenmile graben and Lisbon Valley faults may be structurally related to the Moab fault in that they may have all formed during Tertiary extension, but these faults are not

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213/ Woodward-Clyde Federal Services, "Evaluation of Potential Seismic and Salt Dissolution Hazards at the Atlas Uranium Mill Tailings Site, Moab, Utah," ("Potential Seismic and Salt Dissolution") January 1996. (Appendix 18).

214/ Myron Fliegel, NRC Project Manager, Conversation Record of Telecon on Atlas Geology Open Issues, March 27, 1996.

expected to rupture with the Moab fault -- nor is there any definitive evidence that either the Tenmile graben or Lisbon Valley faults are capable structures;

5. Subsurface evidence and map relations suggest that the Moab fault is a shallow structure (within 2 km depth) along much of its length, including in the vicinity of the tailings pile, which accommodated thin-skinned extension over the Moab salt-cored anticline, and would most likely not be capable of producing significant earthquakes. The basis for these conclusions is discussed further below.

Absolute ages for the most recent activity on the Moab fault are poor primarily because multiple periods of extensive erosion during the late Cenozoic removed significant sections of the stratigraphic record (Woodward-Clyde Consultants, 1986; Ely *et al.*, 1986; Patton *et al.*, 1991; Flemming, 1994).[215] As much as 2 to 3 km of section has been eroded from various locations in the Colorado Plateau (Ely, 1982, 1988; Ely *et al.*, 1986). Along the Moab fault, most of the Cretaceous rocks have been removed, and all of any Tertiary sediments that were deposited have apparently been eroded away, even along the downthrown side of the fault. In addition, along much of its length, only very young Quaternary deposits (possibly middle to late Holocene) are preserved along the fault. Despite the lack of intermediate-age markers to better constrain age of faulting, there is considerable body of evidence which, as a whole, strongly suggests that the Moab fault has not been active during the past 35,000 years and most likely has not been repeatedly active during the past 500,000 years. Indeed, all of the evidence suggests that most, if not all of the movement was pre-Quaternary.

During reconnaissance for the Woodward-Clyde report and in previous studies (Baker, 1993; McKnight, 1940; Doelling, 1993; Mulvey, 1995a; Doelling *et al.*, 1995), no evidence for

[215] See Appendix 18 of these comments for full references for this section on seismicity.

offset or warping of any Quaternary deposits or geomorphic features was found. Sediments estimated to be on the order of 150,000 years old bury the fault and do not appear faulted (Mulvey, 1995a). The youngest known features clearly offset by the Moab fault are late Cretaceous to Eocene folds (Doelling, 1985; 1988; Doelling *et al.*, 1995).

The geomorphic expression of the Moab fault indicates very low rates of activity. Although associated age constraints are not conclusive, geomorphic relations suggest that the fault has not been active during the Quaternary. To better quantify what these observations mean in regard to the age of the most-recent activity on the Moab fault, bedrock scarp retreat rates were used to estimate the amount of time required for rocks in the footwall of the Moab fault to erode back from the main fault trace to the present position of the bedrock escarpment. Age estimates for the central section range from 1.2 - 7.5 million years. Ages for the southern section range from 2.0 - 6.0 million years. Distances and resulting ages are more uniform on the southern section probably because lithologies are more uniform and the main fault trace is only approximately located (Doelling *et al.*, 1995). As scarp retreat in Moab-Spanish Valley has probably been facilitated by salt-dissolution collapse, the upper-bound retreat rates are probably most appropriate and so best-estimate ages for the central and southern sections would be on the order of 1.9 and 2.2 million years respectively. Assuming the scarp retreat rates are appropriate for this setting, the age estimates indicate that the Moab fault has been relatively inactive during Quaternary time and most of the displacement is probably pre-Quaternary.

These age estimates are consistent with regional observations. Sediments are typically preserved on the downthrown side of faults. Therefore, the lack of any known Tertiary rocks on

the downthrown block anywhere along the entire Moab fault, and the lack of any known early Quaternary rocks on the downthrown block along the northern and central sections, is somewhat anomalous.

Microearthquake studies in the region show no evidence for earthquakes associated with the Moab fault, the adjacent Lisbon Valley or Tenmile graben faults (Wong and Humphrey, 1989). Although the Lisbon Valley, Tenmile graben faults and northeast valley-margin faults have been reported as suspected Quaternary structures (Hecker, 1993), there is no definitive evidence for Quaternary movement on these structures. In addition, the geometry and style of deformation along the northeast valley-margin faults indicate that these structures are part of a deformation belt related to salt-dissolution collapse along the northeast flank of the Moab salt-cored anticline and are distinctly different from displacements on the Moab fault (Doelling *et al.*, 1995).

Previous studies concluded that the fault was probably related to salt-dissolution subsidence (e.g., Juntoon, 1988; Oviatt, 1988; Hecker, 1993). However, there are multiple lines of evidence which strongly suggest that the primary displacement on the Moab fault is not related to salt-dissolution or salt diapirism, but probably occurred during a period of late Tertiary, thin-skinned extension. First, cross-cutting relations indicate that at least the most recent period of salt dissolution subsidence occurred after movement on the Moab fault (Doelling *et al.*, 1995; Baars and Doelling, 1987). Second, secondary deformation along the northern and central section of the Moab fault is often characterized by veins, *en echelon* vein arrays and cataclastic shear bands that are filled or cemented with calcite and quartz (Burley *et al.*, 1993). Third, total

displacement patterns on the Moab fault are not entirely compatible with patterns of salt-dissolution subsidence. Finally, stratigraphic and structural relations strongly suggest that at least most of the displacement on the Moab fault post-dates even the youngest diapirism that occurred prior to breach of the salt-cored anticline. This lack of differential offsets or any other stratigraphic record of contemporaneous faulting strongly suggests that the primary episode of movement on the Moab fault post-dates and is unrelated to salt diapirism during this time (Permian into Jurassic time).

Additional details and full citations supporting these conclusions can be found in the Woodward-Clyde report in Appendix 18.

- **Open Issue 6**

"The licensee has not provided sufficient information to evaluate the seismic design basis for the site." (DTER p. 1-6)

Response:

Extensive information to establish and evaluate the seismic design basis for the site has been developed in response to the DTER comment by Woodward-Clyde Federal Services and submitted to the NRC in February 1996.[216] The report develops the site seismic design basis using over 70 pages of detailed scientific text and over 60 tables and figures determining the earthquake potential of the Moab fault, the earthquake potential in the site region, the potential for impacts from salt dissolution subsidence, and performing both deterministic and probabilistic ground motion evaluations.

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[216] See Woodward-Clyde, "Potential Seismic and Salt Dissolution," Appendix 18.

The recommended seismic design value for the site reclamation plan is 0.18g, which corresponds to a seismic event with a return period of 10,000 years. Using a seismic design basis event that is expected to occur only once every 10,000 years provides more than adequate conservatism to address the required regulatory period of 200-1000 years.

As required in 10 C.F.R. Part 40, Appendix A Criterion 4e, the design of an uranium mill tailings pile should be based on the ground motions that could be generated by the maximum credible earthquake for the site "based upon an evaluation of earthquake potential considering the regional and local geology and seismology and specific characteristics of local subsurface material." Incorporating NRC's request to include an earthquake which could rupture 50% of the length of the Colorado River seismicity trend would result in the MCE for the Atlas site being an event of M_w 6-1/2 occurring at a source-to-site distance of 5 km (Section 5). The resulting 84th percentile peak horizontal acceleration as calculated according to Appendix A is 0.63g. Such a value has an annual probability of exceedance of 1.3 x 10^{-6} or a return period of about 750,000 years based on the probabilistic seismic hazard analysis. If such a peak horizontal acceleration were to be considered for design, it would exceed the design level of the vast majority of critical facilities in the U.S. The return period is 750 times greater than the 1000-year design life and 3,750 times greater than the 200-year design life as specified in 40 C.F.R. 192.02 and Criterion 6.

As specified in the introduction to 10 C.F.R. Part 40, Appendix A: "Licensees or applicants may propose alternatives to the specific requirements in this Appendix. The alternative proposals may take into account local or regional conditions, including geology,

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topography, hydrology, and meteorology. The commission may find that the proposed alternatives meet stabilization and containment of the site concerned, and a level of protection for public health, safety, and the environment from radiological and non-radiological hazards associated with the sites, which is equivalent to, to the extent practicable, or more stringent than the level which would be achieved by the requirements of this Appendix and the standards promulgated by the Environmental Protection Agency in 40 C.F.R. Part 192, Subparts D and E." Furthermore, Appendix A states that, "in many cases, flexibility is provided in the criteria to allow achieving an optimum tailings disposal program on a site-specific basis."

Atlas recommends that the seismic design criteria for the Atlas site be probabilistically based and that a conservative return period of 10,000 years be adopted. As discussed in Section 5.0 of the Woodward-Clyde report and Section II D.4 above, the NRC endorses the use of probabilistic risk assessment in nuclear regulatory matters (including "Safe Shutdown Earthquake Ground Motion" for reactor sites) as reflected in their recent policy statement dated August 16, 1995. Based on this state-of-the-art probabilistic seismic hazard analysis, the recommended design peak horizontal acceleration is 0.18g. This recommendation is offered as a reasonable and practicable alternative approach to the deterministic 10 C.F.R. 40 Appendix A value of 0.63g. Selection of peak acceleration values greater than 0.18g, which correspond to lower probabilities of exceedance, would certainly result in overly conservative seismic design criteria not consistent with the available geologic, seismologic, and geophysical data pertinent to earthquake hazards in the vicinity of the Atlas site and the interior of the Colorado Plateau or to the potential hazards associated with a uranium mill tailings facility in the event of some loss of containment.

In the probabilistic seismic hazard analysis performed by Bernreuter *et al.* (1995) for Title II uranium tailing sites, peak horizontal accelerations were calculated assuming a probability of exceedance of 10^{-4} (return period of 10,000 years). This value was adopted because, in authors' opinion, it satisfied the criteria cited in 10 C.F.R. 40 Appendix A. Furthermore, the authors state that such a probability of exceedance may be too conservative for design because of the "relatively low risk posed by the tailings piles." For comparison, the current design life for the proposed underground nuclear waste repository at Yucca Mountain, Nevada is 10,000 years. Because Atlas considers a 10,000 return period to be very conservative compared to the required 1,000 years cited in 40 C.F.R. § 192.02 and Criterion 6, the recommended design value of 0.18g provides the level of protection "equivalent to, to the extent practicable" stipulated in 10 C.F.R. Part 40, Appendix A.

Extensive additional details and full references supporting the seismic design basis can be found in the Woodward-Clyde report in Appendix 18.

- **Open Issue 8**:

"The staff cannot conclude that the slopes of the disposal cell are designed to endure the effects of the geologic processes and events, including resistance to earthquake and settlement, to which they may reasonably be subjected during the design life and that the analyses have been made in a manner consistent with Chapter 2 of the SRP (NRC, 1993)." (DTER p. 1-6)

Response:

Resolution of open issue 6 that the seismic design peak horizontal acceleration is less than 0.25g will close this issue. The only open part of this issue is what design peak horizontal

acceleration to use as input to the analysis; there is no disagreement concerning the analytic technique for evaluating the integrity of the disposal cell. Atlas has performed an evaluation of the disposal cell which indicates that the slopes of the disposal cell maintain their integrity at a design peak horizontal acceleration of at least 0.25g or below.[217] Therefore, this issue is closed in tandem with Open Issue 6 using the existing disposal cell integrity evaluation when agreement is reached on a seismic design peak horizontal acceleration for the Atlas Moab site of 0.25g or less.

(7) DS

- **Open Issue 9**:

"The licensee is currently reevaluating the liquefaction potential for the site. The staff's liquefaction analysis review has been suspended until the licensee's reevaluation is complete and the results are made available. Thus, the staff cannot conclude that there is adequate assurance of safety with respect to liquefaction damage." (DTER p. 1-6)

(8) DS

Response:

Analysis of the liquefaction potential for the site indicates that the probability of occurrence is extremely low over the 200-1000 year regulatory time period. The liquefaction potential for the site is analyzed in detail in a report by Atlas' experts that was submitted to the NRC in February 1996 in response to the DTER.[218]

217/ Canonie Environmental, "NRC Request for Information - Atlas Corporation Reclamation Plan Uranium Mill and Disposal Tailings Area," June 1994. (Appendix 18).

218/ Woodward-Clyde Federal Services, "Evaluation of Potential Seismic and Salt Dissolution Hazards at the Atlas Uranium Mill Tailings Site, Moab, Utah," January 1996 ("Potential Seismic and Salt Dissolution"). (Appendix 18).

Strong ground shaking can trigger the dynamic failure of saturated cohesionless soils by liquefaction. The soils temporarily lose strength during the shaking and acquire a degree of mobility sufficient to permit ground deformation. In extreme cases, the soil particles become suspended in groundwater and the soil mass reacts as a fluid. Liquefaction is triggered when the pore pressure in a soil mass builds up to equal the confining pressure. This pore pressure generation results from the rearranging of soil grains to form a denser structure during the dynamic loading. Static load is then transferred from the intergranular contacts to the pore fluid. If the soil is sufficiently dense, the grains cannot rearrange and liquefaction and pore pressure generation cannot occur. Thus, three conditions are required for liquefaction to occur: (1) cohensionless soils of loose to medium density; (2) saturated conditions; and (3) rapid, large strain, cyclic loading.

Rare instances of liquefaction are predicted for groundwater conditions similar to those studied in the Woodward-Clyde Report but destabilization of the embankment and tailings due to widespread soil failures is not indicated. Liquefaction of the native soils is predicted if the groundwater rises to within 5 feet of the ground surface simultaneously with a M_w 5.5 earthquake, having a peak ground acceleration of 0.20g.

Woodward-Clyde has computed the likelihood of the joint occurrence of the M_w 5.5 earthquake and inundation assuming the two events are not statistically coupled. The 40,000 cfs discharge rate will be equaled or exceeded approximately 0.8% of the time. The return period of the 0.20g is about 10,000 years, which corresponds to an annual frequency of 10^{-4}. The combined annual frequency that the M_w 5.5 earthquake coincides with the posited flood event is

8×10^{-7} or a return period of 1,250,000 years. Thus, although liquefaction is indeed predicted to occur under certain conditions, the likelihood is vanishingly small, and the hazard posed is negligible, over the 1,000 year design life of the Atlas tailings pile.

(8) DSR

(b) Subsidence (Open Issues 2 and 3)

Open Issues 2 (site subsidence) and 3 (impact of buried scarp) defines the potential for subsidence at the Atlas Moab site. Subsidence would be caused by dissolution of the salt strata in the bedrock underlying the site, followed by collapse of the bedrock to fill in the void left by mobilization and migration of the salt. The buried scarp could cause such subsidence to be irregular over the area of the tailings pile. The subsidence issue is addressed in a report by Woodward-Clyde Federal Services that was submitted to the NRC in February 1996. (Appendix 18)

- **Open Issue 2**

"The nature and consequences of the buried fault or scarp beneath the southern edge of the tailings." (DTER p. 1-5)

PSJ

Response:

This issue is directly related to Open Issue 3 and the two are responded to together below.

- **Open Issue 3**

"The nature and rate of future subsidence at the site." (DTER p. 1-5)

Response:

Extensive site investigations and analysis by Atlas' experts show that the expected nature and rate of subsidence at the site will not cause a problem for the reclamation plan design over the 200-1000 year period. These findings are detailed in the Woodward-Clyde report developed in response to the DTER and submitted to NRC. The report demonstrates that a "maximum of 0.08 to 0.2 m of vertical subsidence is expected in 200 years, and a maximum or 0.4 to 1 m is expected in 1000 years. The nature of the subsidence is expected to occur as a slow process, not unlike aseismic creep, . . . of small incremental displacements."[219]

The subsidence along the fault zone may induce some deformations within the tailings pile. The potential impact of this slow subsidence at a rate of 0.4-1 mm/yr on the stability of the tailings pile embankment is addressed using mainly engineering judgment, assuming a conservative evaluation of the strain propagation within the tailings mass, and the upper-bound subsidence rate. The tailings embankment will be approximately 20 m high after closure. The main trace of the Moab fault is located near the toe of the embankment to the northeast. Subsidiary faults of the main trace were inferred to lie beneath the northeast portion of the embankment within a zone approximately 260 m wide. Assuming a conservative 1 mm/yr subsidence rate within the fault zone and that the strain will propagate vertically through the younger alluvium and the tailings without further dispersion, the resulting strain rate in the tailings material will be about 3.8×10^{-6}/yr. The strain accumulation in a 1000-year period will be about 0.00038 or 0.038%. The amount of shear strain expected to accumulate in 1000 years is

[219] Woodward-Clyde "Potential Seismic and Salt Dissolution" p. 3-8, Appendix 18.

too small to affect the stability of the tailings pile as a result of inherent shear stress accumulation from the subsidence.

An alternative assumption would be to consider that the subsidence is occurring along a single fault trace at a depth of about 15 m below the tailings embankment. The vertical movement along the single fault plane would propagate shear strain across the 15-m thick young alluvium and the 20-m high embankment. Fifteen m of young alluvium is assumed based on borings 8, B-17, and B-22 reported by Dames & Moore (1978, 1979) along the northeast section of the embankment. These borings were drilled to maximum depths, within the young alluvium. varying between 15 and 19 m. Assuming that the stress and strain rates induced by the subsidence of 1 mm/yr will fan out at an angle of about 30° from vertical, the expected shear strain rate that would develop at the top of the embankment would be about 0.0025%/yr. This strain rate is considered too small to cause substantial strength loss in the tailings material.

To ensure the conservatism of the reclamation plan design, Atlas also will do a bounding analysis to determine the maximum subsidence the tailings reclamation plan design can accommodate while still performing its technical functions of radon attenuation, erosion protection, and groundwater infiltration minimization over the time period of 200-1000 years. The maximum subsidence the tailing reclamation plan design can accommodate will then be compared to the expected range of subsidence over the 1000 year period. If the reclamation design can withstand greater site subsidence than the range expected over 1000 years, then the subsidence issue will be closed. This bounding calculation is expected to be complete in the near future. After this analysis is complete, the results will be documented and submitted to NRC.

(9) PS

(c) Surface Rock Movement (Open Issues 4, 5, and 14)

These open issues address the potential for near-site rock masses to move towards the site and to impair the function of the surface water drainage channels in the reclamation plan design. Erosion of the engineered features by either surface water or wind was extensively evaluated in the DTER and no open issues were found with the Atlas reclamation plan design. The concerns raised in the three open issues are the potential for sand, from wind-driven surface migration. or landslides from the Poison Spider Mesa to migrate onto the Atlas site and disrupt the function of site design features. These issues were explicitly addressed by Atlas' scientific experts and responded to in the March 1996 report submitted to the NRC.[220/]

- **Open Issue 4**

"Whether or not, or in what way, migrating sand dunes might adversely affect the tailings in the future." (DTER p. 1-6)

Response:

This issue is addressed in the March 1996 Atlas submittal to the NRC. The analyses done to date indicate that migrating sand dunes will not cause a problem to either the earthen cover of the tailing pile or the site drainage channels.[221/] A previous field investigation by Smith Environmental (Smith Environmental, 1995) determined that the Quaternary eolian sand deposits

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220/ Smith Environmental, "Response to NRC Open Issues: Atlas Corporation Reclamation Plan Uranium Mill and Tailings Disposal Area, 88-067-33," March 1996 ("Open Issues 4, 5 and 14") See Appendix 17. Full cites for references in this section are contained in Appendix 17.

221/ Indeed, with respect to the tailings piles erosion protection cover Criterion 4(f) calls for impoundment design that will promote deposition of sediments to enhance the thickness of the tailings cover system--a potential contradiction not discussed in the DTER.

present northwest and west of the tailings pile are currently very stable. Although evidence of sand transport appears to be from all directions, the dominant direction of sand movement is along the Poison Spider Mesa escarpment and to the southeast. Extensive movement toward the pile is not evident.

Discussions with NRC concerning this response indicate staff is not concerned about sand dune movement toward the pile through the processes of saltation, accretion and encroachment. NRC is more concerned about suspension-type movement caused by turbulent flow.

Using EPA (1985) factors for emissions, Atlas' experts performed particulate calculations to determine the length of time required to accumulate 1 inch of sand on the tailings pile. Conservative source areas, as noted on the attached maps, were used in the calculations. Field observations reveal that actual sand deposits are not continuous throughout these areas. Another assumption used in the calculations is that 100 percent of the suspended particulates are deposited on the tailings pile. In reality, of course, not all of the source area sand would be deposited on the tailings pile. Assuming an even deposition of sand on the pile, approximately 35 years would be required for 1 inch of sand to accumulate on the pile.

Not included in the calculations is the fact that sand accumulating on the pile is subject to resuspension. Sand could be moved off the pile by turbulent wind flow or deposited at other locations on the pile by encroachment. Encroachment occurs when the depositional surface is rough and marked by obstructions like an abrupt rise or drop (Thornbury, 1962), such as the impoundment surface water collection ditches and the impoundment drainage channel.

Resuspension is expected to be minimized because of the riprap cover and sand collection in the interstitial spaces between the riprap rock fragments.

If sand deposition were to occur, the extrapolated accumulation rate over a 2-year period would be approximately 0.03 inch (0.8 millimeter). When considering that the greatest expected 1-hour precipitation and 1-day precipitation events for a 2-year period are 0.6 inch and 1.0 inch (NRC, 1996b), respectively, sand accumulation of this magnitude will not obstruct ditch or channel flow. In considering deposition caused by encroachment, an extrapolated accumulation rate five times the normal deposition rate will only result in approximately 0.15 inch (4 millimeters) of sand accumulation in the ditches and channels. However, since not all the sand will be deposited on the tailings pile, the actual sand accumulations will be markedly less than the calculated accumulations.

This analysis is believed sufficient to close the migrating sand dunes issue, but just to ensure that issue is addressed in every possible way, Atlas will analyze what would occur if all the near-site source area sand actually did migrate to the site and deposit in the drainage channels. The potential for blockage of the drainage channels by sand is not expected to be a problem, but, for completeness, Atlas is reanalyzing the issue to demonstrate this conclusion. The only remaining action to close open issue 4 is a field investigation to ascertain the location, abundance, and migrability of surface sands near the Atlas Moab site. The work will include calculations to determine whether the amount of sand expected to migrate into the site drainage channels would be flushed out by a 2-5 year precipitation event from water drainage through the

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channel. These actions are expected to be complete in the very near term and the resulting conclusions will be documented in a report submitted to the NRC.

- **Open Issue 5**:

"Whether or not a potential landslide hazard exists from Poison Spider Mesa escarpment." (DTER p. 1-6)

Response:

Recent mapping subsequent to the DTER of the unconsolidated material and slope angle of the Poison Spider Mesa escarpment adjacent to the Atlas site does not indicate any landslide hazard. The recent detailed geological mapping was used as input to an analytic evaluation of cross sections of the slope which indicates that the slope of Poison Spider Mesa adjacent to the site does not lend itself to landslides.[222] If required, additional field investigations will be performed to reaffirm the findings of the recent detailed geologic mapping of Poison Spider Mesa which indicate that there is no landslide hazard adjacent to the Atlas site.

The analyses performed to address the Poison Spider Mesa landslide issues are summarized in the March 1996 Atlas submittal to the NRC. (Appendix 17) The analyses of the potential landslide hazard from Poison Spider Mesa revealed that the only potential hazard is from rockfall. Smith Environmental's investigation indicates that the deposit mapped as landslide debris by Huntoon et al. (1982) is a talus pile, susceptible only to creep. The potential for creep impacting the reclaimed tailings pile is discussed below.

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[222] Smith Environmental Technologies Corporation, "Response to NRC Open Issues: Atlas Corporation Reclamation Plan Uranium Mill and Tailings Disposal Area", 88-067-33, March 1996. (Appendix 17).

As indicated in a response to NRC comments (Smith Environmental, 1995), the design for erosion protection of the tailings pile side slopes along the Southwest Runoff Drainage Channel (SRDC) has been revised (Canonie Environmental Services Corp., 1995). The revised design is based on an assumption that the SRDC will be approximately 50 percent blocked by rockfall material at various locations along the length of the channel. This revised design will be incorporated into the Reclamation Plan.

The potential landslide hazard from Poison Spider Mesa was investigated by preparing cross sections from geologic maps from Huntoon et al. (1982), Doelling (1993) and Doelling et al. (1995), reviewing the site literature, and consulting the geologists responsible for the geologic mapping in the Moab area. Based on the compilation of data from these sources, Atlas' conclusions are that the only potential hazard from Poison Spider Mesa is from rockfall, and the deposit, previously mapped as landslide debris (Huntoon et al., 1982), is a remnant of a mostly intact bedrock block with accompanying talus debris. The deposit, previously mapped by Huntoon et al. (1982) as landslide debris, is not landslide debris by Huntoon's own admission and as corroborated by Woodward-Clyde Federal Services (Smith Environmental, 1995) and the recent geologic mapping of Doelling (1993) and Doelling et al. (1995). Huntoon (personal communication, February 7, 1996) commented that the area he previously mapped as a Quarternary landslide is a remnant of a hanging wall block that was displaced because of the west branch at the Moab Fault. This remnant is mostly intact with some talus debris. He also indicated that the occurrence is not a Torreva block (Reiche, 1937).

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Michael Ross was also questioned whether the material west of the tailings pile was the result of a landslide. His response was that it was probably talus sitting on faulted rocks and that the combination of talus on the slope with rocks with parallel joints gives it the impression that it moved en masse although it most likely did not (personal communication, February 9, 1996). Woodward-Clyde in its response to comments (Smith Environmental, 1995) was similarly questioned and concluded that this was not a landslide block because its characteristics and geometry were more consistent with exposures of a downthrown block, observed elsewhere, along the main Moab Fault. The more recent geologic maps, prepared by Doelling (1993) and Doelling et al. (1995) for the purpose of expanding the Quaternary mapping, show this area as talus deposits. An added note is that the hazards assessment of the Moab-Spanish Valley by Mulvey (1995, in press) was based on the more recent geologic maps of Doelling et al. (1995).

The potential for landsliding in the form of block slides from Poison Spider Mesa is low to non-existent. Passive factors, such as inherently weak formations, alternation of competent and incompetent layers, steeply-dipping bedding and fracture/joint planes, indicated by Sharpe (1960) as being factors necessary for block slides to occur are not present. The exposed rocks in the canyon wall are comprised of sandstones, siltstones and mudstones, all of which are fairly stable under normal atmospheric conditions. The bedding plane of these units dips approximately 12 to 14 degrees to the southwest (away from the valley).

Fracture/joint patterns are discontinuous and many may not intersect between units. Some of the fractures/joints are unique to the specific lithologic unit and some are more general, affecting all units (Ross, personal communication, February 9, 1996). Even within the units,

many fractures are not continuous, appearing to be related to the growth of the salt diapir underlying the site area. Woodward-Clyde (Smith Environmental, 1995) in its examination of aerial photographs noted an absence of fracturing parallel to the edge of the escarpment, open fissures or any other fractures suggestive of active slope movement. Gregory French made similar comments during his site investigation (Smith Environmental, 1995).

The potential hazard due to landslide on the tailings pile and the SRDC is limited. Observations recorded by rangers stationed at national parks within the Colorado Plateau reveal that often the blocks involved in rockfall either shatter into smaller pieces or completely disintegrate upon impact (Schumm and Chorley, 1966). This would indicate that the talus thickness is very shallow. Doelling et al. (1995) and Doelling (1993) estimated a thickness no greater than 15 to 20 feet for talus debris in the Grand County area. With the exception of a rockfall, French indicated a maximum talus debris thickness of just over 10 feet along Poison Spider Mesa adjacent to the tailings pile. The effect that scarp retreat will have on the production of talus is related to the accumulation of talus; talus accumulation tends to inhibit retreat of the scarp (Schumm and Chorley, 1966). Some estimates of scarp retreat for the Colorado Plateau have been about 0.002 to 0.012 foot/year (ft/yr) (Schumm and Chorley, 1966) and about 0.00066 to 0.00165 ft/yr (Woodward-Clyde, 1996). At these retreat rates, the accumulation of talus at the base of the scarp would not be sufficient to cause an increased threat to the tailings impoundment and drainage channel.

Woodward-Clyde (1996) estimated subsidence rates related to salt dissolution for the long-term to range from 0.08 to 0.2 millimeter per year (mm/yr) and for the short-term to range

PS-11

from 0.4 to 1 mm/yr. Assuming all this subsidence would occur on the main Moab Fault yields estimates of 0.4 to 1 meter over 1,000 years of maximum expected differential subsidence (Woodward-Clyde, 1996). Subsidence of 1 meter over 1,000 years in the valley or on the escarpment will not significantly steepen the escarpment slope such that the potential for landslides will increase.

Three areas of possible concern for mass wasting were observed by French (Smith Environmental, 1995). One area was below the cliff-face (Photo 10, Smith Environmental, 1995) and two others were within the talus material (Photos 6 and 12, Smith Environmental, 1995). Figure 1 of Appendix 17 shows their locations.

The area below the cliff-face was described by French as evidence of a previous rockfall with a geometric configuration of 150 feet long by 40 feet high and 20 feet deep, which broke into pieces upon impact at the base. The potential for rockfall was described in the previous section. The observations French made are consistent with those noted by Schumm and Chorley (1966) in that rockfalls break into pieces upon impact. The two other locations, shown on Figure 1 of Appendix 17, are just above the road cut and south of the area affected by the reclamation activities. Failure in this area would not affect the site.

- **Open Issue 14**:

"Consequences, with respect to erosion protection, of severe landslides have not been adequately addressed." (DTER p. 1-7)

Response:

If the Poison Spider Mesa presents no landslide hazard adjacent to the Atlas site, then there can be no consequences on erosion protection of the tailings pile. This issue is directly related to the resolution of Open Issue 5 regarding the likelihood of landslides adjacent to the site. To assure that this issue presents no problem to the reclamation plan design, Atlas has deliberately overdesigned the erosion protection of the drainage channel adjacent to the Poison Spider Mesa to be able to function as required for full runoff flow conditions with 50 percent of the discharge channel blocked by rockfall (conservatively assumed to be the result of a non-mechanistic source). This issue is addressed in the March 1996 Atlas submittal to the NRC. (Appendix 17)

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(ii) Procedural/Implementation Open Issues

Five procedural/implementation open issues were identified for site and design criteria. The issues can be combined into three groups: additional tailings characterization (open issue 7); cover construction specifications and procedures (open issues 10 and 12); and update design and technical specifications (open issues 11 and 13). All of the issues relate to the development of plans, procedures, and specifications for the implementation of the reclamation plan design evaluated in the DTER. All of these issues begin with the assumption that the underlying design is in compliance, and address the implementation of the technically suitable design.

Open Issue 7 - Additional Tailings Characterization:

"In order to complete the characterization of the tailings and the settlement analysis, the licensee needs to submit additional piezocone information. Prior to approval of the settlement evaluation,

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the licensee should submit a field exploration plan for the piezocone exploration program." (DTER, p. 1-6)

Response:

This is a procedural implementation issue requiring a field testing plan for additional testing of tailings pile settlement. This does not implicate the underlying technical suitability of the reclamation plan design. Atlas will develop a field testing plan for additional piezocone testing of the tailings to demonstrate tailings settlement and will include the plan with the comprehensive update to the Reclamation Plan that will be completed expeditiously following resolution of the technical open issues.

13
DSR

- **Open Issue 10 - Cover Construction Specification and Procedures:**

"The licensee should provide adequate, detailed construction specifications (or a quality assurance program) for field testing the moisture content of the radon barrier soils when lift placement is interrupted." (DTER p 1-6)

Response:

This is a procedural implementation issue requiring revision to the Technical Specifications for site construction. This does not implicate the underlying technical suitability of the radon attenuation cover design, rather it addresses only how the design is implemented. Atlas will include the construction specifications for field testing the moisture content of radon barrier materials when lift placement is interrupted in a revision to the Technical Specifications for site construction that will be completed following resolution of the technical open issues, and subject to actual timing of implementation requirements.

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DSR

- **Open Issue 12 - Cover Construction Specification and Procedures:**

"The specifications permit the placement of fill in 18-inch-thick lifts however, such lift thicknesses make uniform compaction difficult to achieve. The licensee should either specify more workable lift thicknesses or describe applicable procedures for verifying that thorough compaction has been achieved."

Response:

This is a procedural implementation issue requiring revision to the Technical Specifications for site construction. This does not implicate the underlying technical suitability of the radon attenuation cover design, rather it addresses only how the design is implemented. Atlas will include the workable lift thickness and the procedures for verifying uniform and thorough compaction of the lifts in a revision to the Technical Specifications for site construction that will be completed following resolution of the technical open issues, subject to actual timing of implementation requirements.

- **Open Issue 11 - Update Design and Technical Specifications:**

"Portions of the technical specifications have been superseded by later submittals, such as the revised cover design, however, the specifications have not been updated to reflect these revisions. The technical specifications need to be consistent with the reclamation design." (DTER p. 1-6)

Response:

This is a procedural issue requiring updates to the existing Technical Specifications for the reclamation plan design. This does not implicate the underlying technical suitability of the design. Atlas will include the updates, including the revised cover design, in a revision to the

Technical Specifications that will be completed following resolution of the technical open issues and subject to actual timing of implementation requirements.

Open Issue 13 - Update Design and Technical Specifications

"The licensee has not formally submitted revisions to erosion protection features that have been revised, subsequently, inconsistencies with previous submittals exist. Additionally, details of layer thicknesses and gradation have not been provided." (DTER p. 1-6)

Response:

This is a procedural issue requiring updates and clarification to the existing Reclamation Plan. This does not implicate the underlying technical suitability of the erosion protection design. Atlas will include the revised erosion protection features, including details on layer thicknesses and gradation, in the comprehensive update to the site Reclamation Plan that will be completed expeditiously following resolution of the technical open issues.

e. Criteria 5 and 13 - Water Resource Protection

The DTER evaluates the water resource protection aspects of the Atlas surface reclamation plan. The DTER identifies only three open issues for groundwater protection including characterizing the groundwater flow direction and the site background and clarifying the steps to be taken to include the benefits of the radon attenuation barrier in groundwater corrective action. The complete ground-water protection and treatment plan is addressed in the Atlas Moab site Ground Water Corrective Action Plan (CAP) [Appendix 6 - Atlas Corporation Ground Water Corrective Action Plan Uranium Mill and Tailings Disposal Area, Response to NRC information request, Canonie, July 1994]. Precisely because the two inquiries are so

interdependent, the Reclamation Plan and groundwater CAP must be performed sequentially. Any additional groundwater corrective action requirements will be a function of whether the tailings will be reclaimed in place, and hence whether site access will be restricted, or not. Any final groundwater CAP therefore cannot be selected or implemented until the Reclamation Plan for the Atlas site is defined with finality. (18 MC

(19 MC

The type and quantity of contaminants in the Atlas site groundwater is very well characterized. Atlas initiated monitoring of site water resources approximately 20 years ago in 1976 to support its license renewal application in 1983. The groundwater monitoring program was further broadened shortly thereafter when the NRC promulgated new regulations for operating uranium mills in Criterion 7 of 10 C.F.R. Part 40, Appendix A. These regulations required the testing not only of groundwater, but also the tailings liquid itself to determine the potential contaminants that may enter the groundwater at a specific site. The new regulations required detection monitoring, compliance monitoring, and corrective action programs for tailings impoundments. The Atlas site has been operating under these stringent regulations for over ten years.

The water protection regulations in Criterion 13 of 10 C.F.R. Part 40, Appendix A adopt the extensive EPA list of hazardous groundwater constituents in 40 C.F.R. Part 261, Appendix VIII in the definition of hazardous constituents in groundwater. NRC initiated a sampling plan for Title II site tailings solutions to establish which of the hazardous constituents were detectable in the tailings solutions and would subsequently need to be monitored at the site. The extensive testing used advanced scientific methods to test for volatile and semi-volatile organics, total and

dissolved metals, total and dissolved radionuclides, total organic carbon, cyanide, sulfides, various nitrogen containing species, as well as selected anions and cations. Those constituents that were not detected in the tailings for a specific site would not have to be monitored at that site.

Tailings solutions from the Atlas site was tested for all 375 hazardous constituents in the six-page list included in Criterion 13, and only 44 constituents were detected in the tailings solution, as shown in Table 5-2 of the DTER. Groundwater sampling was performed for these constituents. As a result of inability to detect in the groundwater, arsenic, iron, manganese, potassium, thorium-230, lead-210, polonium-210, among others, were removed from the constituent list. Continued groundwater testing demonstrates that, as of 1993, NRC groundwater standards are exceeded for only 5 of the 375 hazardous constituents in Criterion 13: molybdenum, uranium, selenium, vanadium, and gross alpha (primarily radium-226). Thus, while the Atlas site groundwater between the tailings pile and the Colorado River has been contaminated, the scope of contamination is small relative to the potential for groundwater contamination addressed by EPA and NRC in Criterion 13 of 10 C.F.R. 40, Appendix A.

As noted above, Criterion 5 establishes three alternative methods to comply with the groundwater protection requirements. The three methods provide flexibility that allows different sites, each with its own site specific characteristics, to tailor compliance plans that meet the goals of protecting groundwater at each site in a manner that is appropriate and efficient for the characteristics of that site. Each of the three methods is considered a fully appropriate way to comply with the groundwater protection standards of the criterion. Criterion 5B(5)(a) provides

the most basic method, which is to meet the *background concentration* for constituents at the site, as though the source had never been there. Criterion 5B(5)(b) provides a set of MCLs for specific constituents based on drinking water standards as an additional means of complying with groundwater protection requirements. While the background standard in the criterion is assumed to pose "no incremental hazard" and the drinking water standard is assumed to result in an "acceptable hazard," it is acknowledged that they "may not be practically achievable at a specific site." In response, the regulation includes the site specific Criterion 5B(5)(c) which provides the additional flexibility to comply with "alternate concentration limit(s) established by the Commission." These ACLs must "present no significant hazard." The licensee proposes the ACLs on a site-specific, case-by-case basis, providing the "basis for any proposed limits including consideration of practicable corrective actions [and demonstrating] that limits are as low as reasonably achievable." ACLs have been proposed and approved by the NRC at other uranium handling facility sites. NRC recently granted ACLs to the Atlantic Richfield Corporation (ARCO) Bluewater uranium mill tailings site for uranium (0.44 and 2.15 mg/l, equivalent to 300-1470 pCi/l), selenium (0.05 mg/l), and molybdenum (0.10 mg/l) at the point of compliance. In evaluating the proposal, the NRC staff stated that "(w)hile it is possible that ARCO could propose and achieve lower ACLs, the staff see no significant gain with respect to human health and the environment." [NRC Technical Evaluation Report on ARCO's ACL Petition for the Bluewater Millsite, at 3, Draft, October 31, 1995.] Additional examples of ACLs that have been granted for other uranium handling facility sites include uranium (7,385 pCi/l at Westinghouse Electric Bruni, Texas site), radium-226 (1536.5 pCi/l at the Mobil Oil Corp. Brelum, Texas site), and molybdenum (3.55 mg/l at the Everest Exploration, Inc. Hobson, Texas

site). Eventually, the groundwater corrective actions proposed for the Atlas site could include proposed ACLs.

Atlas has investigated the groundwater corrective action alternatives assuming on-site tailings reclamation that would be designed to bring site groundwater into compliance with the NRC regulations in Criterion 5. The next step, however, is to decide on the final surface reclamation plan for the tailings. Once the reclamation plan is finalized, one of the groundwater corrective actions already defined, or an action not yet defined, could be addressed in detail, submitted for approval, and implemented.

The four engineering-feasible groundwater corrective actions identified and evaluated by Atlas in the July 1994 Ground Water CAP report (Appendix 6) are:

- Alternative 1 - Limited Action Alternative which utilizes the components of the Reclamation Plan (Canonie, 1992) including infiltration and runoff control, affected soil removal, institutional controls and groundwater monitoring.

- Alternative 2 - Hydraulic gradient control using a downgradient injection trench to feed river water to the groundwater table with an upgradient pumping system and evaporation of extracted groundwater.

- Alternative 3 - Partially penetrating slurry wall with an upgradient pumping system and evaporation of extracted groundwater.

- Alternative 4 - Ground water extraction with soda ash treatment as a primary treatment, reverse osmosis as a polishing step, and ultimate discharge to the Colorado River.

All of the alternatives are projected to reach proposed ACLs (10 C.F.R. 40 Appendix B, Criterion 5B(5)(c)) within 35 years and would meet NRC values for ground-water protection (10 C.F.R. 40 Appendix B, Criterion 5B(5)(b)) and Criterion 5C) within 70 years. All of the

alternatives except Alternative 1 would require the development of a new evaporation pond on top of the current tailings pile and, ultimately, disposition of significant amounts of sludges (which will include radionuclide components) created by the water treatment activities. Alternative 1 is the preferred approach because it accomplishes the same goal as the other alternatives in a similar time frame at a lower cost (Ground Water CAP report, Canonie, July 1994 - Appendix 6).

Important site specific features of the Atlas Moab site make the groundwater issue more benign than it may be at other tailings sites. As noted above, the groundwater near the Moab site has such a naturally high salinity and high concentration of dissolved solids that it is classified as not fit for human consumption. Any groundwater near the site would require treatment prior to human consumption. The tailings pile has increased the concentration of three contaminants in the groundwater downgradient of the tailings, between the pile and the Colorado River. The contamination has effectively no impact, however, because the groundwater flow direction is from the direction of the tailings pile to the river, crossing only Atlas site land, and there are no groundwater users downgradient of the site before the groundwater is diluted by the Colorado River. There are only 16 registered water users within one mile of the tailings site. The only two water rights for groundwater are upgradient of the site. The remaining users have rights allocated from the Colorado River or other surface water points, and "surface water monitoring for the last 20 years indicates there is no measurable increase of the contaminants in the Colorado River." (DTER, p. 5-23) Therefore, in practice, any contamination of near-site groundwater from the tailings pile has had no impact on human health and safety. 20 MC

The radon attenuation barrier that plays such a key role in the surface reclamation plan will also be a key part of the groundwater corrective action plan. At the same time it keeps radon in, the very low permeability radon barrier will keep water out. This barrier will minimize infiltration of water into the tailings, which will minimize water going from the tailings pile into the groundwater. Although the overall groundwater CAP is to be addressed separately, the DTER points out in an open issue that any use of the radon barrier for groundwater control must be addressed in the reclamation plan because the single design concept that would be finalized in the reclamation plan will perform both functions. The use of the radon barrier for both functions is addressed below in Open Issue 17.

21
MC

(i) **Technical Open Issues**

The DTER identifies three technical open issues with respect to water resource protection at the Moab site.

- **Open Issue 15**:

"The licensee must provide additional data to support its interpretation of groundwater flow directions and gradients in the alluvial aquifer near the southern property boundary of the site." (DTER p. 1-7)

22 MCi

Response:

The response to this issue was submitted by Atlas to the NRC in the Smith Environmental Technologies report (Appendix 16).

The groundwater contour map for the shallow alluvium at the site has been revised as shown in Figure 1 of Appendix 16. The revisions are consistent with the NRC interpretation in the DTER that the groundwater flow direction from the tailings is parallel to the upland area and towards the Colorado River. The new groundwater flow direction indicates that in the southern portion of the site the major component of groundwater flow originates from the direction of the tailings and not the bedrock upland area. This revision is believed by Atlas to be sufficient to close the open issue.

The revisions are based on the low conductivity of the bedrock upland area south of the site, additional Colorado River water level data collected by Mussetter Engineering, Inc. (MEI) (1994) and the exclusion of groundwater level data from Well ATP-1-S. MEI (1994) collected

water level elevation data form the Colorado River along several cross-sections during April 1994. A map of the MEI study showing the location of the 14 cross sections is shown on Figure 2.1 of the document entitled "Geomorphic. Hydraulic and Lateral Migration Characteristics of the Colorado River. Moab, Utah" (MEI, 1994). Table 1 of Appendix 16 lists the number of the cross section, the distance between cross sections, the water level elevation of the Colorado River at each cross section and the surface water gradient.

The points where Cross Sections 5 and 6 (XS 5 and XS 6) cross the west bank of the Colorado River are shown on Figure 1 of Appendix 16. These two points represent the locations of surface water elevation measurements collected during April 1994 by MEI (1994). Additional surface water level elevations along the Colorado River northeast of XS 5 and south of XS 6 were approximated based on the surface water gradient between cross sections (i.e., between XS 4 and XS 5 and between XS 6 and XS 7) and are also shown on Figure 1 of Appendix 16. The surface water elevation data derived from the MEI cross sections were used to revise the groundwater contour map of the shallow alluvium at the site along the river.

The revision of the contour map involved the exclusion of the groundwater level elevation from Well ATP-1-S from the map. As discussed in the groundwater CAP (Appendix 6), the approximate elevation of the fresh water/brine interface is 3,855 feet above mean sea level (ft amsl). In Well ATP-1-S, the tops of the filter pack and the screen interval are at elevations of 3,845.7 and 3,820.7 ft amsl, respectively. Therefore, the groundwater elevation from Well ATP-1-S is not representative of the shallow portion of the alluvial aquifer and hence was excluded from the revised groundwater level contour map.

Using the information presented above in the interpretation, the groundwater level contour map for the shallow alluvium has been changed from the interpretation presented in the groundwater CAP (Appendix 6). As shown on Figure 1 of Appendix 16, revisions to the map include the south area near the property boundary, the area in the vicinity of Well ATP-1-S, the area in the vicinity of the mill and along the Colorado River. Groundwater flow directions and gradients have been changed accordingly. The revised groundwater flow directions now support the contaminant concentration contours presented on Figures 5, 6 and 7 of the groundwater CAP (Appendix 6). However, it must be noted that the contaminant concentration contours represent the use of only three data points, Wells ATP-2, AMM-2 and AMM-3, in the interpretation. 23 MC

- **Open Issue 16**:

"The licensee must provide data showing that monitoring well AMM-1 is not influenced by contaminants form the former ore storage pad." (DTER p. 1-7) 23 MC

Response:

Further analysis of over 10 years of monitoring data demonstrate that monitoring well AMM-1, the "baseline" groundwater well for the site, is not influenced by site contaminants from the former ore storage pads or the tailings pile. The groundwater in the alluvium under the site is naturally not fit for human consumption, as discussed above, because it contains elevated salinity and concentrations of naturally occurring solids, including uranium, radium, and selenium. A comparison of trends for well AMM-1 with other wells on the site, coupled with an understanding of the water flow directions and gradients (discussed in Open Issue 15),

demonstrates that the well is not being influenced by site contaminants from either the former ore storage pads or the tailings pile.

The concentrations of dissolved solids in well AMM-1 have remained consistent over time, while the dissolved solids in other monitoring wells at the site have fluctuated up and down consistent with the operation of the mill, the location of unmilled uranium ore on the ore storage pads, and the production of tailings. While the levels of solids in AMM-1 remained constant after 1984, when mill operations and use of the ore storage pads ceased, the other monitoring wells have shown a steady decline in concentrations after tailings production ceased. This is what one would predict because well AMM-1 is upgradient of the former ore storage pads and the tailings pile is in the opposite direction of groundwater flow, while the other monitoring wells are downgradient of the ore storage pads and the tailings in the direction of groundwater flow from the tailings to the Colorado River.

Table 2 of Appendix 16 presents the sample analysis results from well AMM-1 for selenium, radium Ra-226/Ra-228, combined Ra-226/Ra-228 and natural uranium (NatU) for the period from March 1988 to November 1993. Figures 2, 3 and 4 of Appendix 16 present graphs of the selected constituents for the same period of time. As shown in Table 2 of Appendix 16, selenium concentrations have averaged 0.009 mg/l for the 14 samples and have exceeded the NRC MCL for selenium of 0.01 mg/l on nine occasions. However, the table illustrates that during the sampling period, selenium concentrations have been consistently in the range of 9 to 9.92 mg/l, except for the May 1992 result which was nondetect.

As shown in Table 2 and on Figure 3 of Appendix 16, combined Ra-226/Ra-228 concentrations have not exceeded the NRC MCL of 5 pCi/l during the nine sampling events when both Ra-226 and Ra-228 were sampled. For the nine sample results, combined Ra-226/Ra-228 averaged 0.611 pCi/l. The standard deviations of the sample populations for Ra-226 and Ra-228 of 0.185 and 0.226, respectively, indicate consistent constituent concentrations during the sampling period.

As shown in Table 2 and on Figure 4 of Appendix 16, NatU exceeded the NRC MCL of 4 pCi/l at only one sampling event. Due to the magnitude of that one value (October 1992, 113.0 pCi/l), it appears that laboratory error or field contamination may have been involved. Figure 4 shows that the October 1992 NatU concentration exceeds the other sampling events by two orders of magnitude. Table 2 of Appendix 16 indicates 12 samples were collected during the period from September 1988 and November 1993. The average concentration for the 12 sample results was 11.88 pCi/l. However, if the sample result for October 1992 is excluded from the population, then the average of 11 NatU results is 2.68 pCi/l. The standard deviation of the sample population, excluding the October 1992 sample result is 0.69, indicating consistent NatU concentrations during the sampling period.

Trend analyses of selenium, Ra-226, Ra-228 and NatU for other monitoring wells and piezometers at the site indicate that generally the concentrations were increasing until 1984, which was the year the mill shut down. Since then, the trend has reversed and a substantial decrease in concentrations has been observed for all wells and piezometers. However, concentrations at well AMM-1 have been consistent over time indicating that the former ore

23 Mc

storage pads had no effect on the groundwater in the vicinity of well AMM-1. If the ore pads had affected the groundwater, then constituent concentrations in well AMM-1 would also be declining since removal of the ore.

In addition, as shown on Figure 1 of Appendix 16, the groundwater flow direction from the former ore storage pads is southeast toward the Colorado River. If contaminants from the former ore storage pads had influenced well AMM-1, then groundwater flow in the area would have to be from west to east. Water level data from well AMM-1 and the Colorado River indicate that the well is upgradient of the river. Courthouse Wash is also located northeast of the former ore storage pads and well AMM-1. Hydraulic influence from the wash should force groundwater to flow in a southerly direction. Even during high water events on the Colorado River when the river loses water, well AMM-1 is upgradient of the former ore storage pads due to the configuration of the river and Courthouse Wash (i.e., groundwater flow would be in a westerly direction).

This analysis of the groundwater flow directions in the vicinity of well AMM-1 and the consistent constituent concentrations over time reaffirm the previous determination that well AMM-1 is an appropriate background groundwater monitoring point.

- **Open Issue 17**:

"The licensee must clarify whether it plans to take engineering credit for any disposal cell component for meeting compliance with the groundwater protection standards for the site. If engineering credit is taken, costs associated with achieving the necessary cover permeability must be incorporated into the reclamation plan." (DTER p. 1-7)

Response:

Atlas will take engineering credit for the earthen cover radiation attenuation barrier as part of a synergistic environmental protection system that will isolate tailings constituents from the surface and groundwater. The clay barrier that is so efficient and durable in attenuating radon release to the surface is also ideally suited to minimize the infiltration of water into the tailings pile. Minimizing water infiltration into the pile will greatly reduce the quantity of contaminants that otherwise might end up in groundwater at the site.

Atlas believes that this synergistic design approach to surface and groundwater protection is the most cohesive and beneficial overall strategy to reclamation of the site. Therefore, Atlas plans to take engineering credit for the design aspects of the tailings pile cover and meeting, in part, the groundwater protection standards as specified in License Condition No. 17 of Source Material License SUA-917, and Criterion 5 of Appendix A to 10 C.F.R. Part 40. Engineering credit is based on minimizing infiltration by providing a nearly impervious cover and efficiently channeling precipitation off the pile. Implementation of the Reclamation Plan will reduce the driving force for constituent migration and minimize leaching due to infiltration. It is expected that constituent concentrations will continue to decrease with the implementation of the Reclamation Plan, as indicated in the groundwater CAP (Appendix 6). Additional discussion on this can be found in the recent submission by Atlas' expert. (Appendix 16)

The specific elements of the design related to groundwater corrective action are as follows:

1. Regrading of the impoundment top to reduce settlement, increase long-term stability, reduce infiltration and enhance runoff.

In changing the initial dome-type top cover to a channel-top type, the height of the tailings pile was decreased by 33 feet. This modification in cover configuration will reduce tailings visibility, settlement, subsequent cracking and damage to the soil cover, and reduce infiltration. The embankment slopes were steepened to 10H:3V from the 5H:1V slopes which were requested for evaluation by the license condition. The steepened slopes require increased rock armor thickness for erosion protection, however, the steeper slopes reduce surface water infiltration thereby reducing the potential for seepage from the tailings.

2. Creating a system of three ditches merging into one channel on the impoundment top to produce surface water drainage.

In the original dome-type top configuration, the cover was to be graded to allow for efficient surface water runoff. However, in changing the cover configuration to include a system of three ditches merging into one channel, the runoff residence time on the cover was reduced and flow is to be directed in a controlled manner to the reconfigured Moab Wash channel, thereby decreasing infiltration and erosion potential.

3. Use of the Mancos shale borrow materials as a clay layer in the cap to reduce infiltration.

The original infiltration calculations for the pile cover were based on using materials from Moab Wash, which had a permeability of 9.5×10^{-5} centimeters per second (cm/sec). To improve radon attenuation capabilities of the cap, the Mancos shale material was sampled and determined to have a permeability of 1.7×10^{-7} cm/sec, two orders of magnitude greater than the initially

selected material. Laboratory data relating to the borrow source investigation were included in the 1992 Reclamation Plan (Canonie, 1992).

An initial estimate of costs associated with the Reclamation Plan was provided in the Engineer's Report (Canonie, 1988). A revised cost estimate was provided as a response to an NRC Request for Information in December 1993 (Canonie, 1993). Costs associated with achieving the cover permeability needed to take engineering credit for groundwater protection will be included in revised cost estimates associated with the comprehensive update to the Reclamation Plan.

24 MC

(ii) Procedural Open Issues

There are no procedural open issues under Criterion 5.

f. Criterion 6 - Radon Attenuation

The DTER found no technical open issues for the radon attenuation and site cleanup plan for the Atlas Moab facility. The radon attenuation and site cleanup plan is explicitly addressed in Chapter 6 of the DTER. The only open issues identified in the DTER are procedural/implementation issues and administrative confirmation items.

Criterion 6 requires that the tailings shall be covered by an "earthen cover" to "limit releases of radon . . . so as not to exceed an average release rate of 20 picocuries per square meter per second to the extent practicable throughout the effective design life." This radon attenuation barrier must provide "reasonable assurance of control of (radon release) . . . for 1,000 years, to the extent reasonably achievable, and, in any case, for at least 200 years." Thus, criterion 6

establishes the design approach (earthen cover), design lifetime (200-1000 years), and the release specification (20 pCi/m^2/s). The criterion allows flexibility on a site specific basis by requiring compliance with the specification "to the extent practicable."

The degree of certainty required for compliance with the criterion is "reasonable assurance," a more flexible definition than that used in short time-frame regulatory actions. The regulatory period of 1000 years is significantly longer that typical facility regulatory periods of 20-40 years. The degree of certainty applicable to a 20-40 year period is clearly different from a 1000 year period which introduces additional variables that cannot be definitively ascertained. Thus, NRC has applied the compliance criteria of *reasonable assurance* to the radon attenuation cover for a tailings pile. This standard is a rational compromise between the need to have confidence in the inherent quality of the design approach and the inherent uncertainty of long-term performance predictions. (See Section II, D.4. above)

The DTER evaluates Atlas' radon attenuation cover design as found in the Reclamation Plan and its revisions (June 1992, April 1993, and May 1994) for the Moab site. The radon attenuation plan uses an earthen cover designed to maintain average radon emissions from the tailings below 20 pCi/m^2/s for 1000 years, with *reasonable assurance*. The DTER did not identify any technical suitability problems with the radon attenuation cover design proposed by Atlas for the Moab site. The DTER did raise issues with respect to confirming that the design is implemented in the way it is proposed. These implementation issues involve methods for sampling and characterizing the soil and clay materials that will be used in the earthen cover.

Sampling plans and procedures are needed to give *reasonable assurance* that the technically suitable radon attenuation cover design will be implemented the way it is currently documented.

Criterion 6 also requires that any part of the site not under the engineered earthen cover "not exceed the background level by . . . more that 5 picocuries per gram (pCi/g) of radium-226 . . . averaged over the first 15 centimeters (cm) below the surface, and . . . over (succeeding) 15-cm thick layers" (commonly referred to as the "5/15 rule"). Atlas will meet the 5/15 rule by recovering any soil on the site that has an average radium concentration greater than the 5/15 limit. This recovered "affected" soil will be included in the tailings pile underneath the earthen cover, and will provide an additional barrier between the tailings and the environment.

Criterion 6 states a clear preference in favor of implementing the final radon barrier as soon as possible. Criterion 6A, a subset of criterion 6, requires that the "final radon barrier must be completed as expeditiously as possible considering technological feasibility after the (site) ceases operation." The Atlas Moab facility reclamation plan satisfies the policy underlying this requirement by immediately implementing deployment of the radon attenuation barrier as soon as the plan is approved, rather that waiting decades to implement a different alternative. It should be noted that Atlas has already satisfied an initial step in this process by covering the pile with an interim cover.

- **Open Issues:**

The NRC DTER evaluation of the Atlas site radon attenuation and site cleanup plan identified no technical open issues and three procedural/implementation open issues. In addition, three confirmatory items, which require purely administrative action, were identified.

(i) Technical Open Issues

There are no technical open issues under Criterion 6.

(ii) Procedural/Implementation Open Issues

Three procedural/implementation issues were identified for the radon attenuation and site cleanup plan. These issues begin with the assumption that the underlying technical issues are in compliance, and address the implementation of the technically suitable design. The three issues here all address the Ra-226 sampling plan and survey procedures for the tailings, the soil cover, and the clay barrier material to verify that the actual implementation of reclamation is consistent with the approved reclamation plan, and thereby with Criterion 6.

- **Open Issue 18:**

"The licensee must provide a sampling plan for Ra-226 analysis of the upper 3-4 feet of coarse tailing and the technical basis for modeling the coarse tailings on the sideslopes as being homogeneous (i.e., a single layer) for Ra-226 concentration." (DTER p. 1-7) 25 ESB

Response:

This is a procedural implementation issue requiring a revision to the Reclamation Plan. This does not implicate the underlying technical suitability of the radon attenuation cover design rather it addresses only how the design will be implemented. Atlas will include a sampling plan for the Ra-226 content of the upper 3-4 feet of coarse tailings and will address the technical basis for modeling the tailings sideslope as homogenous in the comprehensive update to the Reclamation Plan that will be completed expeditiously following resolution of the technical open issues.

- **Open Issue 19**:

"The licensee must provide the gamma survey and sampling procedures for verification of tailings cleanup in the Moab Wash sandy soil borrow area for NRC approval. Also provide revised Reclamation Plan Specifications (Section 1.14 and 5.3.3) and page 40 of the text to indicate that the background soil Ra-226 value is the average value approved by NRC to demonstrate that the radon barrier will comply with Criterion 6 (5) ." (DTER p. -17)

Response:

This is a procedural implementation issue requiring revisions to the Reclamation Plan and associated soil testing procedures. This does not implicate the underlying technical suitability of the radon attenuation cover design. Atlas will provide a gamma survey/sampling procedure for the soils in the Moab Wash borrow area and will include appropriate revisions for soil Ra-226 background value with the comprehensive update to the Reclamation Plan. Both will be completed expeditiously following resolution of the technical open issues, subject to actual timing of the implementation requirements.

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- **Open Issue 20:**

"The licensee must include in the testing program for the clay borrow material, analysis and/or gamma surveys to determine its Ra-226 value, to demonstrate that the radon barrier will comply with Criterion 6 (5)." (DTER p. 1-7)

Response:

This is a procedural implementation issue requiring revisions to the Reclamation Plan. This does not implicate the underlying technical suitability of the radon attenuation cover design. Atlas will develop analytical or survey procedures to demonstrate the clay barrier material contains background levels of Ra-226 and include them with the comprehensive update to the Reclamation Plan that will be completed expeditiously following resolution of the technical open issues.

(iii) Confirmatory Items

NRC identified three "Confirmatory Items" in the DTER which require purely administrative action to close. The three items relate to updating the documentation for the Atlas Moab facility to reflect the final design and process for reclaiming the site as agreed to by NRC and Atlas. These revisions must be made for the license amendment to be complete. The primary document for this is the Reclamation Plan. The Reclamation Plan will be updated expeditiously following resolution of the technical open issues.

- **Confirmatory Item 1**

"Provide revised Reclamation Plan pages pertaining to the method of composite sampling for ore and tailings to accurately describe the sampling program." (DTER p. 1-8)

Response:

This is an administrative implementation issue requiring updates to the existing Reclamation Plan. This does not implicate the underlying technical suitability of the radon attenuation cover design. Atlas will include a full description of the composite sampling plan for the ore and tailings in the comprehensive update to the site Reclamation Plan that will be completed expeditiously following resolution of the technical open issues.

- **Confirmatory Item 2:**

"Incorporate in the Reclamation Plan, the proposed testing program for 'affected' soil to substantiate the radon flux model/calculation parameter values." (DTER p. 1-8)

Response:

This is an administrative implementation issue requiring updates to the existing Reclamation Plan. This does not implicate the underlying technical suitability of the radon attenuation cover design. Atlas will include a full description of the testing program for "affected" soil in the comprehensive update to the site Reclamation Plan that will be completed expeditiously following resolution of the technical open issues.

- **Confirmatory Item 3**:

"Incorporate in the Reclamation Plan, the final clay borrow area proposed testing program to substantiate the radon flux model parameter values for the clay material." (DTER p. 1-8)

Response:

This is an administrative implementation issue requiring updates to the existing Reclamation Plan. This does not implicate the underlying technical suitability of the tailings radon attenuation cover design. Atlas will include a full description of the testing program for the clay borrow material in the comprehensive update to the site Reclamation Plan that will be completed expeditiously following resolution of the technical open issues.

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V. CONCLUSION

For all of the foregoing reasons, Atlas requests that NRC issue a Final EIS (FEIS) and a Final TER (FTER) finding Atlas' on-site reclamation plan for the Moab site acceptable, and grant a license amendment that allows Atlas to proceed expeditiously with on-site reclamation.

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April 29, 1996

BY HAND DELIVERY

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Re: Draft Technical Evaluation Report for the Proposed Revised Reclamation Plan for the Atlas Corporation Moab Mill; Source Material License No. SUA 917

Dear Mr. Holonich:

Grand County Council, the governing body for Grand County, Utah, in which the Atlas Corporation Moab Mill ("the Atlas Site") is located, provides the following comments with regard to the Draft Technical Evaluation Report ("DTER") issued by the staff of the U.S. Nuclear Regulatory Commission, Office of Nuclear Material Safety and Safeguards ("NRC staff") on January 30, 1996.

As demonstrated below, the DTER is premature and legally insufficient under NRC's own regulations and applicable statutory requirements. In general, NRC staff has failed to require Atlas Corporation ("Atlas") to comply with the basic technical licensing requirements applicable to the final "reclamation" of uranium mill wastes. (10 C.F.R. Part 40, Appendix A, referred to in these comments as "the Appendix A criteria".) Specifically, Atlas plans to leave 10.5 million tons of radioactive waste on the banks of the Colorado River, within a mile of Moab city limits, and across the highway from Arches National Park. Especially because of the long-term negative environmental consequences of the Atlas plan, as recognized by the NRC in its Draft Environmental Impact Statement ("DEIS"), the technical elements of Atlas' plan should have been strictly scrutinized and conservatively

evaluated by NRC staff. Instead, NRC staff repeatedly has let Atlas off the hook by: (1) relying on Atlas' estimates and promises, without carefully analyzing Atlas' plan; (2) failing to apply the NRC's own policies regarding the technical evaluation which is required; (3) impermissibly excusing Atlas from compliance with NRC regulations; and (4) severing from this regulatorily-required technical evaluation process, analysis of some of the most important licensing conditions. NRC staff's assessment of Atlas' compliance with the licensing conditions is flawed and was issued too soon. Therefore, as a matter of law, Atlas should be required to submit a revised reclamation plan. NRC staff then should perform a thorough technical review of the revised plan, which should then be available for further public comment.

I. The DTER's Introductory Section Contains Significant Omissions and Errors.

The NRC's regulations obligate it "to conduct its domestic licensing . . . functions in a manner which is both receptive to environmental concerns and consistent with the Commission's responsibility . . . for protecting the radiological health and safety of the public." (10 C.F.R. § 51.10 (b).) This dedication to protecting the environment and the public health and safety is further embodied in the NRC's regulatory and statutory goals which must be met when NRC staff conducts a technical evaluation process, resulting in a Technical Evaluation Report ("TER"). Pursuant to federal statute and regulations, the NRC may not approve a reclamation plan unless it meets the thirteen technical criteria set forth in 10 C.F.R. Part 40, Appendix A. As NRC staff acknowledges, the policy guidance with regard to these criteria, provided in the Final Standard Review Plan ("SRP") for UMTRCA Title I sites, is also applicable to the Atlas Site. (DTER, pp. 1-5, 2-1.) Because Atlas' plan and NRC staff's review of that plan does not comply with these statutory, regulatory, and policy requirements, the DTER should be withdrawn, and Atlas and NRC staff should be required to comply with the law.

A. Background (DTER, § 1.1.)[1]

In the introductory section of the DTER, NRC staff states that a draft TER is prepared when there is "sufficient information" to document staff's review and to support its conclusions. (DTER, p. 1-1.) However, NRC staff also admits

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[1] Throughout these comments, references to sections of the DTER will be referred to as "DTER, § ____"; references to pages of the DTER will be referred to as "DTER, p. ____".

that, in this case, it has prepared a DTER despite the fact that there are twenty "open issues" and many additional items which still must be confirmed by NRC staff. (DTER, pp. 1-5 to 1-8.) Thus, NRC staff's report is a partial and preliminary DTER, sufficiently evaluating only a limited portion of the licensing criteria.[2]

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In the DTER, NRC staff states that it "can not support the issuance of a license amendment approving the proposed reclamation plan" until these open issues "are adequately resolved." (DTER, p. 1-5.) Nevertheless, NRC staff gives no schedule or timetable by which it expects to resolve these open issues; indeed, it notes that these issues presently remain open only because NRC staff's "previous rounds of questions and requests for information" to Atlas have not yet produced responsive answers. (DTER, p. 1-5.) However, in the case of some of these open issues, NRC staff proceeds to analyze Atlas' compliance with the technical licensing requirement by assuming that the technical requirements have been met. For example, regarding the technical issue of whether the Moab Fault, on which the Atlas Site is located, is a capable fault, NRC staff analyzes whether the Atlas Site's location has "seismic potential . . . based on the assumption that the Moab Fault is <u>not</u> a capable fault." (DTER, p. 2-16, emphasis added.) A regulatorily sufficient DTER cannot be issued until NRC has conducted a "thorough, focused, efficient, and consistent" review that is "properly documented." (SRP, p. 3.) Because so many open issues remain to be analyzed, NRC staff should require Atlas to submit a complete reclamation plan, which NRC staff should then subject to a new technical review, conducted in compliance with NRC's own strict standards, and make this new plan and review available for public comment.

B. <u>Site Description</u> (DTER, § 1.2.)

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NRC staff's description of the Atlas Site contains several descriptive errors. These errors have repercussions throughout the DTER, skewing NRC staff's analysis and conclusions. For example, NRC staff states in Section 1.2.1, and repeatedly throughout the DTER, that the Atlas Site is three miles or more northwest of Moab. In fact, the Atlas

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[2] As discussed below, in addition to the open issues with respect to the technical disciplines it evaluated in this report, NRC staff has intentionally avoided any evaluation of Atlas' compliance with Criteria 5, 7, and 13. The NRC staff must prepare a new DTER which includes an analysis of water resources protection and make it available for public comment. This analyses must be included in the TER process for all licensing criteria for the Atlas Site.

tailings pile is only 1.5 miles from the Moab city limits. Moreover, the boundaries of the "Atlas Mill Site," as diagramed in Figure 1-1 (DTER, p. 1-3.), are within a mile of the city limits. Because compliance with Criterion 1 requires that the tailings pile be remote from populated areas, NRC staff's misstatement of these facts is a critical error. Furthermore, one of the closest areas in Moab to the Atlas Site contains residential development. In addition, NRC staff does not note that the city is planning to annex property to the northwest to accommodate Moab's growing population and tourist economy.

The Site Description also does not mention that the Atlas Site is across the highway from Arches National Park. Nor does NRC staff discuss the varied recreational, tourist, and cultural activities which occur in the immediate and surrounding area. Again, these uses must be evaluated when determining Atlas' compliance with the Appendix A criteria; therefore, NRC staff's description of the Atlas Site is insufficient to analyze Atlas' compliance with these criteria.

II. The DTER's Geologic Stability Section Contains Multiple Unresolved Issues and Deficiencies.

At the outset of the DTER's section on geologic stability (DTER, § 2), NRC staff states the licensing requirements which Atlas must meet with regard to geologic stability pursuant to the Appendix A criteria, i.e., the Atlas tailings disposal area must be closed "in accordance with a design which provides reasonable assurance of control of radiological hazards to be effective for 1000 years, to the extent reasonably achievable, and, in any case, for at least 200 years." (DTER, p. 2-1.) According to NRC staff, this standard means that "certain geologic and seismologic conditions [such as Criteria 4(e) and 6] must be met in order to have reasonable assurance that the long-term performance objectives will be met." (DTER, p. 2-1.)

In order to meet Criterior 4(e), according to NRC staff, the tailings "may not be located near a capable fault that could cause a maximum credible earthquake larger than that which the tailings could reasonably be expected to withstand." (DTER, p. 2-1.) In order to meet Criterion 6, according to NRC staff, Atlas must provide "information on the alluvium and bedrock beneath the tailings sufficient to demonstrate a design that ensures that potential future disruptions of the radon and erosion protection barriers will meet NRC requirements." (DTER, p. 2-1.) NRC policy regarding how NRC staff is to evaluate Atlas' compliance with these standards is provided in the NRC's SRP. (DTER, p. 2-1.)

Although the applicable legal standards are clear, NRC staff has often failed either to consider or to analyze sufficiently numerous crucial aspects of the "geologic and seismologic conditions [which] must be met in order to have reasonable assurance that the long-term objectives will be met." (DTER, p. 2-1.) Although not exhaustive, we provide, below, some of the most serious deficiencies in NRC staff's analysis of the issues pertaining to geologic stability.

A. Stratigraphy (DTER, § 2.3.2.)

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A basic deficiency in NRC staff's evaluation of the Atlas Site's stratigraphic setting (DTER, § 2.3.2) is that it completely fails to discuss the stratigraphy of the Site itself. According to NRC staff, Atlas still has not "characterized the Quaternary alluvium, the Paleozoic and, if present, the Mesozoic rocks, or the basement rocks beneath the site to the extent necessary to support conclusions of subsurface and bedrock stability." (DTER, p. 2-3.) NRC staff has attempted to remedy Atlas' omission in this regard by "compiling" information about the general stratigraphic setting from the literature and from discussions with Utah Geological Survey ("UGS") geologists. (DTER, p. 2-1.) As a result, however, NRC staff's discussions of stratigraphy focus only on regional conditions.

For example, Atlas should, but apparently has not provided information on the following important site-specific stratigraphic issues:

1) What Mesozoic unit directly underlies the Atlas Site?

2) What are the thickness of the bedrock units underlying the Atlas Site?

3) What is the depth to the top of the Paradox Formation or other evaporite units that pose great hazards to the stability of the Atlas Site?

In particular, in the subsection regarding Quaternary stratigraphy (DTER, § 2.3.2.2), NRC staff should also discuss the lithologies of the Quaternary unconsolidated deposits. Specifically, this discussion should include such technical information as bedding thickness, grain size, moisture content, and other data, as needed, to allow for a proper seismotectonic evaluation of the Atlas Site's geologic stability. Without such technical data, NRC staff does not have the knowledge necessary to assure compliance with the applicable standards in Appendix A, particularly Criteria 4(e) and 6.

The DTER cannot be considered complete without an adequate and technically accurate description of the Atlas Site's specific stratigraphy. Thus, the site-specific stratigraphy must be determined before any reasoned analysis of the Atlas Site's geologic stability can occur. Atlas' failure to provide site-specific stratigraphy should be treated as another open issue.

In DTER § 2.3.2.2, NRC staff has inadequately described, or has accepted Atlas' inadequate description of, technical data necessary to assess fully important geologic stability issues. For example, NRC staff notes that Atlas "plans to investigate" latest Quaternary rates of stream incision of Courthouse Wash "in order to constrain maximum subsidence rates for Moab Valley." (DTER, p. 2-5.) NRC staff should include the actual results of this investigation in the DTER, not merely mention Atlas' intent to investigate them. It is the necessary technical data themselves, not Atlas' plans to acquire such data, which NRC staff should examine in order to fully and adequately describe the Quaternary stratigraphy.

Similarly, in DTER § 2.4, NRC staff references a subsequent section of the DTER to conclude that Atlas has assessed the effects of talus encroachment and rock falls into the drainage system on the western side of the pile. However, in that referenced DTER § 4.5.1.3.2, NRC staff's discussion of sediment considerations contains only the bare statement that Atlas assumed "large rocks would be deposited" in the Southwest Diversion Channel. (DTER, p. 4-20.) These assumptions about rock falls do not constitute a technically sufficient evaluation of this issue. Thus, NRC staff has not required Atlas to assess adequately the effects of rock falls and talus encroachment. NRC staff must require Atlas to conduct a fuller analysis of such important issues in order to assure compliance with the applicable standards in Appendix A, particularly Criteria 4(e) and 6.

B. <u>Structural Setting and Features</u> (DTER, § 2.3.3.)

In the Structural Setting portion of the DTER, NRC staff admits that it does not know whether the Moab Fault exists under the Atlas Site. (DTER, p. 2-5.) The most conclusive statement NRC staff makes about the likely existence and location of the Moab Fault is that, "Atlas appears to agree with the UGS interpretation that a splay of the Moab Fault system underlies the site but appears to disagree with interpretations which suggest that the main Moab Fault underlies the site. . . ." (DTER, p. 2-5 (citation omitted).) The most certainty NRC staff offers regarding resolution of this important issue is Atlas' promise to investigate the issue to gather the "primary data," which the SRP requires to be included before the staff may determine

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that Atlas' geologic, bedrock, and seismotectonic stability investigative activities and technical information are "appropriately presented." (DTER, p. 2-6; SRP, pp. 9-13.) 6 PS.

If NRC staff now cannot state with certainty whether the Moab Fault exists beneath the tailings pile, there is no basis for NRC staff's subsequent determinations of the geologic or seismic consequences of implementing the Atlas plan. To determine the geologic and seismic consequences of the Atlas Site, NRC staff must know, with scientific certainty, whether the foundation upon which the waste pile will rest is competent bedrock or shifting sand. Yet, at the outset of the DTER, NRC staff admits that it does not know whether the Moab Fault exists under the tailings pile. This is a grave deficiency violating NRC staff's obligations to assure compliance with Appendix A Criteria, particularly Criteria 4(e) and 6. Furthermore, NRC staff's failure to correct this deficiency violates the NRC's policies regarding the standards for adequate investigation of geologic and seismic issues. (See, e.g., SRP, pp. 9-13.) The DTER cannot be considered complete until NRC staff accurately and completely determines the geological characteristics and location of the Moab Fault, and the implications of that information for the stability of the Atlas Site.

More specifically, NRC staff's discussion of structural features contains several technically inadequate references to important geologic features. (DTER, § 2.3.3.1.) Generally, NRC staff should reorganize this subsection to discuss structural features in tectonically related groups. NRC staff's present discussion mixes structures from different tectonic regimes from the Paleozoic to the present, making it difficult for the reader to discern whether NRC staff is properly differentiating paleotectonic features from neotectonic features, such as capable faults. (See, e.g., NRC staff's discussion of features possibly related to Quaternary faulting, followed by its discussion of the Paleozoic setting of the Paradox Basin. (DTER, pp. 2-6 to 2-7.)) NRC staff cannot assure Atlas' compliance with the applicable Appendix A Criteria without demonstrating that it has made a competent analysis of the significance of the distinctions between such differing geologic features. Without such an analysis, the DTER remains incomplete and inadequate. 7 PSJ

C. Diapirism and Subsidence (DTER, §§ 2.3.2.1, 2.3.3.1, 2.3.3.2, 2.3.3.3.)

In addition, NRC staff gives several inconsistent, confusing, or inadequate references to diapirism and subsidence, particularly with respect to their best estimates of the conflicting geological ages during which diapirism may 8 P.

have occurred in the Paradox Formation. First, NRC staff states that syndepositional diapirism controlled the thickness of "late Pennsylvanian to latest Triassic (possibly into the Cretaceous) units." (DTER, p. 2-4.) Subsequently, NRC staff states that diapirism is of the "late Paleozoic through Jurassic" eras. (DTER, p. 2-6.) NRC staff should resolve this inconsistency and state clearly what is the technically correct age/timing of diapirism. (8)

Most importantly, NRC staff's sparse discussion of diapirism does not rule out the possibility that it is occurring today. In fact, NRC staff states later in its discussion that the Moab Fault is related to diapirism and that diapirism may have occurred during the Quaternary era. (DTER, pp. 2-6, 2-7, 2-9.) NRC staff obviously needs to reach, and to convey in the DTER, a clearer understanding of this important geologic feature, particularly as regards to its timing and possible ability to influence the vicinity of the Atlas Site today. Moreover, in DTER § 2.3.3.2, NRC staff notes that Atlas, to date, has failed to consider existing data necessary to fully assess these important geologic stability issues. (DTER, p. 2-7.) Until this analysis is conducted, NRC staff cannot assure compliance with the Appendix A Criteria, particularly 4(e) and 6. (9) PS

For example, NRC staff notes that the only basis Atlas offers to support its postulation of a lower rate of subsidence than has occurred in the past is that subsidence rates "have <u>probably</u> slowed down since the time of Pinedale glaciation (roughly 15,000 to 25,000 years ago) due to a drier climate." (DTER, p. 2-7, emphasis added.) **However, NRC staff also should note that the climate-dissolution relationship suggested by Atlas is not supported by any data, and that this hypothetical line of reasoning may not apply to the Atlas Site. A drier climate could just as easily lead to reduced dissolution of soluble units only on an overall regional scale. However, in locations of perennial recharge (such as at the Atlas Site, which directly overlies the riverbed of the Colorado River), dissolution may be occurring at rates similar to those assumed for Pinedale climatic conditions. NRC staff cannot accept Atlas' unsupported assumption that a climactic consequence "probably" slowed down in the last 15,000 to 25,000 years of geologic time.** (10) PS

At another point in the subsection discussing salt tectonics, NRC staff notes that Atlas observed a borehole beneath the tailings pile, suggesting that subsidence may have occurred and enabled sediments to accumulate there. This observation contradicts Atlas' previous assertion that "there is no evidence for late Quaternary subsidence north of the Colorado River in the vicinity of the tailings pile." (DTER, p. 2-7.) Similarly, NRC staff points to numerous (F

studies and features that may indicate a subsidence risk that has "not yet been considered by Atlas" (DTER, p. 2-7), including the UGS's conclusion that "a range of rates of future subsidence is possible in the site vicinity," and NRC staff's own conclusion that the average rate estimates say little about the potential for rapid subsidence-collapse hazards. (DEIS, p. 2-8.) For NRC staff's analysis of geologic stability issues in the DTER to meet applicable standards, NRC staff must not accept Atlas' inconsistent data. **Nor can NRC staff simply accept Atlas' conclusions with respect to particular features and possible future events, especially when these conclusions are contradicted by the results of other technical studies. In its present form, NRC staff's analysis of salt tectonics (DTER, § 2.3.3.2) is rife with such inconsistencies,** all of which demonstrate a flawed and inadequate analysis of geologic stability issues.

D. <u>Characteristics of the Moab Fault System</u>
(DTER, § 2.3.3.3.)

In its discussion of the characteristics of the Moab Fault system, NRC staff fails to explain the rationale underlying its conclusion that the Moab Fault may not meet the definition of a capable fault. The fact that the Moab Fault may be rooted in a salt-cored anticline and may not be structurally connected to the basement does not necessarily preclude its being a capable structure. (<u>See</u> UGS preliminary geologic map of the Moab area (June 1995).) If NRC staff's line of reasoning were universally followed, many active thin-skin tectonic features throughout the world that do not involve the "basement" (such as thrust faults and low-angle normal faults) would erroneously be considered non-capable faults. Although the Moab Fault may not be reacting to plate tectonic stresses, it is a salt "tectonic" feature. A regional scale anticline as large as the Moab salt-cored anticline (traceable for tens of miles) must be considered a "tectonic feature," whether it was formed by salt diapirism or plate tectonic forces.

In addition, as NRC staff notes, even if the Moab Fault were not a capable fault, it could still represent "a hazard that would need to be assessed because of its proximity to the site." (DEIS, p. 2-9.) In this regard, we question NRC staff's conclusion that the "main" Moab Fault may have overlain the site but has since been removed by erosion. (DEIS, p. 2-8.) NRC staff asserts but does not explain its rationale for reaching this latter conclusion. At a minimum, NRC staff should fully analyze and discuss how it believes

the near-vertical Moab Fault could have overlain the site but then been removed by erosion.[3]

In addition, at a bare minimum, NRC staff must provide a better description of the Moab Fault, including a full analysis of such technical data as the following:

1) What is the original age of fault (if related to diapirism, has it been active since the end of Pennsylvanian)?

2) What is the attitude of the fault (e.g., is it vertical or high-angle)?

3) If it is not exposed at the Atlas Site, where is the closest definitive exposure of the fault to the site?

4) What is the stratigraphic displacement and total displacement (in feet) across the fault?

NRC staff's presentation of a comprehensive and technically accurate description of all geologic and seismic issues pertaining to the Moab Fault is necessary to ensure compliance with the applicable standards in Appendix A, particularly Criteria 4(e) and 6.[4]

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[3] If, for example, the Moab Fault had at one time overlain the site but had since been removed by erosion, then NRC staff should be able to describe the location of the fault trace, which must still be on the ground somewhere adjacent to (east or west of) the Atlas Site.

[4] Another basic deficiency of this subsection is NRC staff's attempt to describe the Moab Fault without using figures or maps of it. Similarly, it seems a basic deficiency of the subsection on topography and geomorphic features for NRC staff to completely fail, in that subsection, to give the elevations of the river, the floodplain, the toe of the tailings pile, and the top of the tailings pile. Without such fundamental and germane comparative data, NRC staff's technical descriptions often lack the specificity needed to fulfill their regulatory obligations. (<u>See</u>, <u>e.g.</u>, SRP § 1.3.2, which states that an investigation of geologic stability is 'appropriately presented' only if it includes the following data: plot plans, stratigraphic profiles and cross sections, and logs of core borings, geophysical investigations and/or test pits. (SRP, pp. 9-10.))

E. Topographical and Geomorphic Features (DTER, § 2.3.4.1.)

In the DTER subsection discussing topography and geomorphic features, NRC staff has inaccurately described the location and nature of several important features. One example of NRC staff's mischaracterization of a significant feature is the statement that Moab Wash "heads at Little Canyon and appears to have captured Little Canyon Wash." (DTER, p. 2-10.) However, review of a USGS topographic map (1:100,000 scale) shows that Little Canyon (and Little Canyon Wash) are distinct tributaries to the Colorado River, and that Little Canyon enters the river over 5 miles downstream from the Site. According to the USGS, the Moab Wash may be eating into the headland area of the Little Canyon Wash, but Moab Wash has not "captured" Little Canyon Wash. In addition, NRC staff refers to several "linear (actually planar) topographic features," which NRC staff asserts -- without further explanation -- are "faults." (DTER, p. 2-10.) NRC staff does not, but should, describe how many such linears/faults it believes occur in this area. Moreover, NRC staff should describe any such features it believes exist in the previous subsection on structural setting. (DTER, § 2.3.3.) Once again, NRC staff fails to make critically important distinctions in its characterizations of the significant geological features in the vicinity of the Atlas Site. Such distinctions must be made before an adequate DTER can be completed. (17 PS

F. Colorado River and Its Tributaries (DTER, § 2.3.4.2.)

In addition, NRC staff inadequately analyzes whether subsidence caused by dissolution of salt has affected migration of the Colorado River in Moab Valley. (DEIS, p. 2-11.) NRC staff merely states that, "There is no conclusive data available which would indicate that subsidence caused by dissolution of salt affected the migration of the Colorado River in Moab Valley." (Id.) The lack of "conclusive data" could just as easily demonstrate that salt dissolution subsidence could have, as well as could not have, affected the migration of the Colorado River. NRC staff's reliance on inconclusive data, and resulting unsupported conclusion, cannot be a basis for determining Atlas' compliance with the applicable Appendix A standards. (18 PS

G. Seismicity (DTER, § 2.3.5.)

NRC staff's discussion of seismicity contains several inconsistent, confusing, or inadequate references to important seismic features. (DTER, § 2.3.5.) For example, NRC staff does not discuss surface rupture potential at all. (1 A

NRC staff also reports an area of apparently induced seismicity (showing an "increased level" of micro-earthquake activity) during a period of brine extraction. (DTER, p. 2-13.) However, NRC staff does not give the location of this area of induced seismicity, nor discuss its possible implications for the Atlas Site. In addition, NRC staff's discussion of potash mining also should include the possibility that active exploration and exploitation for potash mining in the area of the site could produce induced seismicity. (DTER, § 2.4.2.4.) Moreover, NRC staff's statement that earthquakes occur within the upper 20 kilometers of the earth's crust conflicts with its previous statement, on the same page, that the depth of earthquakes varies from shallow to 50 kilometers. (DTER, p. 2-13.) Obviously, both statements cannot be correct. All such omissions and inconsistencies should be adequately analyzed and rectified before the DTER can be considered complete.

H. Open Issues

NRC staff concluded that six issues pertaining to geologic stability remain "open" after NRC staff's analysis of them for the DTER. The first three relate to bedrock stability, and involve determining: 1) the capability of the Moab Fault and its branches; 2) the nature and consequences of the buried scarp at the Atlas Site; and 3) the nature and rate of subsidence. The fourth and fifth open issues relate to geomorphic stability, and involve determining: 4) the effects of migrating sand dunes; and 5) the effect of landslides emanating from Poison Spider Mesa. The sixth open issue relates to seismotectonic stability, and involves determining: 6) the seismic design basis for the Atlas Site.

Although these issues currently are designated "open," NRC staff should be careful not to accept Atlas' data which are contradicted by other, more objective technical studies. For example, an Atlas submission to the NRC had previously found no seismic activity associated with "the postulated northeast-trending feature coinciding with the trend of the Colorado River." (DTER, p. 2-12.) However, as NRC staff notes, Atlas' conclusion is not supported by recent observations, which "indicates that a swarm of seismic activity north of the confluence of the Colorado River and the Green River is associated with this trend." (DTER, p. 2-12.) Neither should NRC staff unjustifiably rely on unspecified and unquantified terms in making technical determinations regarding the issues at stake in this case (e.g., potential faults similar to those exposed across Highway 191 are "likely" to be bounding). (DTER, p. 2-15.)

Most importantly, although NRC staff supposedly has left open its ultimate conclusions regarding certain geologic

stability issues, NRC staff impermissibly assumes that the Atlas plan will comply with Appendix A standards. For example, NRC staff conducts an analysis of seismic potential "based on the assumption that the Moab Fault is not a capable fault." (DTER, p. 2-16, emphasis added.) Although NRC staff admits that its "analysis would have to be revised if the Moab Fault was found to be a capable fault" (DTER, p. 2-16), NRC staff's decision to proceed in this manner is not reasoned scientific decision-making. NRC staff first should remedy the numerous deficiencies in the DTER as discussed above and only then, after setting forth an adequate and comprehensive analysis that fully complies with the applicable regulatory requirements, close the remaining open geologic stability issues.

III. NRC Staff's Evaluation of Geotechnical Stability is Deficient.

A. Site and Material Characterization (DTER, § 3.2.)

NRC staff is required to review Atlas' plan to determine if it has presented a "detailed and quantitative discussion" of the sampling procedures used to define "all the critical soil parameters for the site." (SRP, pp. 18-19.) Included in this requirement is NRC staff's obligation to evaluate the borrow materials. NRC staff's discussion of the investigation of borrow areas does not include any reference to the riprap borrow materials. In light of Atlas' recent decision to abandon its use of Round Mountain rock for riprap, there is no Atlas plan which is ready to be evaluated. Until Atlas presents a final riprap borrow plan, the NRC staff cannot evaluate fully geotechnical issues.

Furthermore, as part of its evaluation of Atlas' geotechnical information, NRC staff is required to review historic groundwater fluctuations. NRC staff has failed to require Atlas to conduct any groundwater fluctuation studies as part of its geotechnical investigation. Therefore, because of its failure to review this information, NRC staff's analysis is incomplete.

Finally, although NRC staff finds that Atlas' geotechnical evaluation is deficient because Atlas has not assessed the geotechnical stability of the "tailings and contaminated material" in the Atlas tailings pile, NRC staff refuses to require Atlas to remedy the situation prior to license approval. Instead, on this critical health and safety issue, NRC staff intends to allow Atlas to conduct its testing while Atlas is constructing the pile's cover. Thus, NRC staff is not demanding strict compliance with the regulations requiring that Atlas demonstrate the waste pile's ability to withstand the construction activity. Instead, NRC

staff intends to approve Atlas' plan prematurely, and hope that no problems are encountered during the construction activity. NRC staff's approach inexcusably puts both the Moab community and the Atlas construction team at risk. NRC staff provides no reason why Atlas should not be required to test the pile's current geotechnical stability before construction begins. Therefore, Atlas' failure to assess completely the geotechnical stability of the tailings pile should be designated as an "open issue."

B. <u>Geotechnical Engineering Evaluation</u> (DTER, § 3.3.)

In order to evaluate the "Geotechnical Engineering" of the Atlas plan, NRC staff must analyze slope stability, settlement and cover cracking, and cover design. Due to inexcusable omissions and other deficiencies in this portion of the DTER analysis, the DTER should be withdrawn.

1. <u>Slope Stability</u> (DTER, § 3.3.1.)

According to NRC staff's introduction to the DTER, the reason Atlas needs a license amendment is because, after the mill closed, Atlas was no longer able to construct a tailings impoundment that met NRC's requirements for height and slope elevations. (DTER, p. 1-1.) Appendix A, Criterion 4, requires that the sideslopes of Atlas' waste pile not exceed 5h:1v, unless Atlas demonstrates that steeper slopes are "impracticable." Criterion 4 is one of the few criteria that has a quantified standard; thus, there is no room for subjective analysis of how this criterion is to be met. Atlas' sideslopes either must be no steeper than 5h:1v, or Atlas must explain why they should be steeper. The burden is on Atlas to show that it should be exempted from the numerical standard.

Despite the clarity of the standard, NRC staff has not required Atlas to comply with it. It is undisputed that Atlas' plan violates the numerical standard in Criterion 4. Atlas plans to construct sideslopes of 10h:3v over most of the pile, except at the southwest corner where the slopes will be 10h:1v. (DTER, p. 4-1.) NRC staff completely obscures Atlas' obligation to comply with the requirements of Criterion 4, and never once discloses that this criterion requires Atlas to prove that less steep slopes are impracticable. (<u>See</u> DTER, § 3.3.1.)

Although NRC staff does not acknowledge that Atlas' side slopes are too steep, apparently staff has concluded that Atlas cannot construct less steep slopes at this site. Indeed, the Atlas pile's proximity to the Colorado River and other features make it unlikely that the slopes can be made

less steep without causing further harm to public health and safety and to the environment.

However, NRC staff's responsibility upon finding that the slopes are too steep does not end by finding that the slopes cannot be made less steep. Rather, this factor -- the impossibility of conformance with Criterion 4 -- requires NRC staff to evaluate whether the Atlas pile should be allowed to remain at a site where steep slopes are required. Atlas' inability to provide less steep slopes affects the pile's stability for multiple reasons -- it affects erosion control, the impact of surface water hydrology, and the effectiveness of the radon barrier. The steep slopes increase the likelihood of active maintenance requirements. Thus, because Atlas' pile will be defective in this fundamental manner, the benefits of moving the pile become even more apparent.

Furthermore, because Atlas' slopes are planned to be steeper than regulatorily-permitted, NRC staff should closely scrutinize Atlas' geotechnical construction plans. Atlas has not shown that such steep slopes can be constructed or that they can stay in place without active maintenance. Indeed, NRC staff has little experience with tailings piles constructed in the manner Atlas suggests. Virtually all Title I sites have slopes less steep than the Atlas proposal slopes.[9] In addition, Atlas has failed to show that its uniquely steep slopes will withstand wind, water, and other natural forces. Moreover, Atlas plans to make its site even more unique. Atlas plans, and NRC staff does not object, to avoid placing a clay layer on its sideslopes. NRC staff does not disclose that every Title I sites is protected by clay on the sideslopes.

Atlas' inability to construct a pile meeting the fundamental standards of pile stability demonstrates the dangers and inadequacies of its plan. The Moab community deserves the same protections as those communities near Title I sites. The Atlas plan's repeated divergence from regulatory criteria should weigh heavily against the acceptability of its overall proposal to reclaim its tailings pile on the banks of the Colorado River, virtually within Moab. Thus, the DTER should be withdrawn to consider more thoroughly the effect of the pile instability and Atlas' failure to comply with Criterion 4.

NRC staff finds that Atlas' plan is deficient because it has not demonstrated that Atlas' design will withstand

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[9] Slopes at 3:1 were allowed at Gunnison because tailings are enclosed by perimeter dikes constructed of uncontaminated soil.

24 DSR
25 DS
26 DS

earthquakes, settlement, and other geologic effects. (DTER, pp. 3-4, 3-5.) However, NRC staff's review of slope stability remains inadequate for its failure to evaluate groundwater conditions as a possible contributor to slope instability. NRC staff's review of slope stability only is "considered acceptable . . . , if it includes . . . a summary and description of the groundwater conditions within or beneath the slope." (SRP, p. 19.) Contrary to the NRC's own policies, no discussion of groundwater conditions nor of those conditions' effect on the pile's stability is raised in this evaluation of slope stability. Thus, pursuant to the NRC's own standards, the DTER is inadequate.

2. Settlement and Cover Cracking (DTER, § 3.3.2.)

NRC staff's conclusion that Atlas' plan demonstrates that its cover design will control radiological hazards, without further maintenance, is based on unsupported assumptions and is inconsistent with NRC staff's conclusions elsewhere in the DTER. NRC staff previously concluded that Atlas has not conducted sufficient testing to ensure that the waste pile will not settle, causing the cover to crack. (DTER, p. 3-2.) In this "Geotechnical Engineering" section of the DTER, NRC is required to determine whether the potential for settlement has been adequately tested. Furthermore, NRC policy requires NRC staff to determine whether Atlas' settlement testing program has been sufficient to determine settlement potential. (SRP, p. 21.) Among other technical requirements, Atlas is supposed to test for settlement occurring instantaneously and over time. (SRP, p. 21.) NRC staff also is required to determine whether Atlas' "settlement estimates represent conservative and tolerable behavior" of the waste pile. (Id., emphasis added.)

NRC staff has abdicated its responsibility to conduct a thorough review of Atlas' settlement testing program. Instead, NRC staff plans to allow Atlas to delay all in-situ settlement testing until after Atlas has begun construction of the waste pile. Furthermore, NRC staff will be required to review and, presumably, approve Atlas' field data under the time pressures of an ongoing construction project. Thus, NRC staff will not be able to conduct the careful and conservative review of settlement data which NRC policy requires to be conducted prior to providing licensing approval to reclamation plans.

3. Cover Design (DTER, § 3.3.4.)

NRC staff's evaluation of the geotechnical long-term stability of the cover design is deficient. Furthermore, NRC staff's acceptance of Atlas' cover design is not consistent

with NRC's technical requirements for Title I sites, and staff has not provided any basis for its abandonment of these requirements.

Although NRC staff does not discuss this issue in the "Geotechnical Engineering" section, in DTER, § 6.2.3 (the "Parameters for Radon Barrier Soils" Section), NRC staff subsequently requires Atlas to conduct further testing of the radon barrier capabilities of the cover materials. NRC staff should also require that the saturated conductivity of the radon/infiltration barrier be at least 10^{-7} centimeters per second, as NRC has required at Title I disposal sites. Furthermore, Atlas should be required to present, and NRC staff to evaluate, the permeability test results of the recommended design value of saturated conductivity of the barrier material. 29 DS

As further criticism of NRC staff's evaluation of the radon/infiltration barrier, we note that the NRC has imposed inadequate hydraulic testing requirements on the radon/infiltration barrier. The NRC recognizes that, due to EPA's groundwater standards, "increasingly limited design hydraulic conductivity (K) values" are being imposed. (SRP, p. 23.) Indeed, permeability test results of 10^{-8} to 10^{-10} cm/sec are now being used for some tailings sites. (Id.) The NRC has stated that it is not good science to rely exclusively on laboratory, rather than field testing, of the permeability of soil materials, because laboratory testing significantly understates actual conductivity.

NRC staff has not imposed these strict hydraulic testing requirements on Atlas. For example, NRC staff states that Atlas laboratory testing of hydraulic conductivity of the Klondike Flats clay is "near 10^{-7} cm/sec." (DTER, p. 3-7.) NRC staff does not state how "near" to 10^{-7} cm/sec those results truly are. Nor does NRC staff indicate that these laboratory results have been adjusted by an order of magnitude to describe increased conductivity under field conditions. Moreover, NRC staff does not discuss how Atlas will impose the rigorous quality control programs required to meet hydraulic conductivity specifications. Most importantly, NRC staff has not required Atlas to meet hydraulic conductivity standards of more than the 10^{-7} cm/sec bare minimum of acceptability. Given the threats to public health and safety and to the environment created by Atlas' waste pile, as recognized by the NRC in the DEIS (DEIS, pp. 2-25 to 2-26), NRC staff must require the most conservative possible hydraulic conductivity specifications.

Furthermore, NRC staff's acceptance of an 8-inch thick layer of clayey soil over the coarse tailings and 12 inches of clayey soil over the fine tailings is inconsistent with

its past requirements for Title I sites. As NRC staff is aware, the minimum cover thickness for Title I waste piles is 18 inches. NRC staff provides no support for its conclusion that an 8-inch layer can be constructed. NRC staff also provides no basis for evaluating whether Atlas has demonstrated that its 12-inch layer will meet Title I specifications. Furthermore, because Atlas has not adequately analyzed the tailings pile, it is not possible, at this point, to determine the soil thickness that is sufficiently protective. 30 DS

Finally, NRC staff's requirements for frost protection at the Atlas Site differ significantly from those specified at Title I sites. In Title I design criteria, the depth of frost penetration is based on a 200-year return period. (UMTRA-DOE/AL 050425.0002, Technical Approach Document, Rev. II, Dec. 1989, p. 63.) For example, the estimated 200-year frost depth at the Slick Rock, Colorado site, 52 miles southeast of Moab, is 35 inches. Therefore, NRC staff's acceptance of a 9-inch sand layer is not protective of the freezing and thawing cycles at the Atlas Site. NRC does not explain why it is not requiring Atlas to provide sufficient and conservative frost protection, as it has required at Title I sites. 31 DS

In sum, NRC staff's analyses of Atlas' compliance with geotechnical requirements is inadequate. NRC staff should require Atlas to complete additional testing of the geotechnical stability of its cover design. Until such testing is analyzed thoroughly by NRC staff, the DTER and its conclusions on geotechnical stability should be withdrawn.

IV. NRC Staff Insufficiently Evaluates Surface Water Hydrology and Its Impact on Erosion Protection.

In the DTER, NRC staff fails to adhere to the NRC's policies which require Atlas to submit a plan providing long-term erosion protection. In order to evaluate the Atlas plan's compliance with the Appendix A Criteria, NRC staff must review hydrologic data, hydrologic analyses, and design details. (SRP, p. 27.) NRC staff's evaluation is required to insure that Atlas' plan meets certain site characteristics (Criterion 1), and certain pile stability standards (Criterion 6). However, NRC staff has failed to enforce these criteria in that neither the physical characteristics of the Atlas Site, nor the Atlas pile design, nor the disposal location promotes long-term stability. Specifically, NRC staff has failed to describe accurately the hydrology of the Atlas Site, determine the flooding potential, to analyze accurately the water surface profiles, and to adhere to its regulations regarding protection from erosion due to the above factors.

A. Hydrologic Description and Site Conceptual Design (DTER, § 4.2.)

In order to analyze the impact of site-specific hydrology on the Atlas Site's ability to withstand erosion, NRC staff must accurately and fully describe the Site's surface water hydrology. NRC staff has failed to perform this fundamental task. NRC staff's mistakes on this issue undermine the conclusions it reaches on the Atlas Site's compliance with the licensing requirements pertaining to erosion protection. Specifically, NRC staff fails to analyze adequately the impact of the Probable Maximum Precipitation and Probable Maximum Flood events on Atlas' proposed design. NRC staff states that "[t]he design basis events for design of erosion protection include the Probable Maximum Precipitation (PMP) and Probable Maximum Flood (PMF) events, both of which are considered to have very low probabilities of occurring during the 1000-year stabilization period." (DTER, p. 4-1, emphasis added.) However, NRC staff's conclusion about the low probabilities of these events are misleading. The very nature of PMP and PMF calculations are that they are low probability events. However, according to NRC policy, it is still necessary to construct designs which protect against these events because, despite the low probability of their occurrence, PMP and PMF events have potentially catastrophic consequences. (SRP, § 3.) Thus, the fact that PMP and PMF have low probabilities of occurrence just restates the obvious and begs the question of whether Atlas' radioactive waste pile's cover will collapse when these events do occur. 32 TL

Furthermore, despite the low probability of PMP and PMF events, over the past 40 to 50 years, the Southwest has experienced many storms and floods which approach the estimated PMP and PMF events. (U.S. Dept. of Interior, Comparison of Estimated Maximum Flood Peaks With Historical Floods, 1986.) Indeed, in the DEIS, the NRC states that the largest flood of record along the Colorado River in Utah occurred in 1984 and "anecdotal evidence indicates that the 1984 flood rose approximately 1.2 m (4 ft) above the toe of the tailings pile." (DEIS, p. 3-18.) Rather than minimizing the likelihood of PMF and PMP events occurring, NRC staff should quantify the impacts of those events and require that Atlas prove that its cover design can withstand them.

B. Flooding Determinations and Water Surface Profiles (SS 4.3 and 4.4.)

As to flooding and water surface profiles, NRC staff has failed to collect sufficient data to verify or to review independently Atlas' models or conclusions. Although NRC staff is required to review water surface profiles, channel

velocities, and shear stresses associated with flood discharges (SRP, p. 28.), the staff has not collected sufficient data to do so. NRC staff's evaluation in this regard is deficient.

In order to evaluate the stability of the pile, NRC staff must verify that Atlas properly selected the critical design flood event. We question whether Atlas has selected the critical design flood event in light of the analyses of the PMF and frequency-based flood data presented in Table 4-3. (DTER, p. 4-12.) As shown in Table 4-3, the critical design event for inundation of the disposal cell is the PMF, whereas less extreme floods are the critical events for flow velocities. (DTER, p. 4-12.) To verify Atlas' conclusions, NRC staff performed a sensitivity study for a large flood discharge up to 600,000 cfs. (DTER, p. 4-12.) However, NRC staff also should have completed a sensitivity analysis for flood flows between 70,000 cfs and 178,000 cfs in order to assess the maximum channel velocity and maximum overbank velocity adjacent to the Atlas Site.

As to water velocity during a flood, the estimated overbank velocities for the cross-section immediately upstream of the site are too low. In its explanation as to why the water velocity is low, NRC staff fails to use conservative assumptions and thus casts doubt on its conclusions. For example, NRC staff finds that low flow velocities during the PMF are due to the Portal, a narrow gorge two miles downstream of the Atlas Site. (DTER, p. 4-12.) However, the reduction in the cross-sectional area of the river at the Portal is not the most likely cause of the low overbank velocities during flood flows that are substantially less than the PMF. It is likely that the simulations with the HEC-2 model give too much credit to overbank vegetation which generally decreases the flow velocity. Rather, a more realistic and conservative scenario would assume that the flood flow strips the overbank of most or all of its vegetation which results in a decrease in the composite roughness coefficient (Manning-'n') for overbank areas. By choosing non-conservative assumptions and variables, NRC staff underestimates the flow velocity adjacent to the Atlas Site. Thus, the calculated water velocity is inaccurate and may be higher. Without a more conservative estimate of water velocity, NRC staff cannot properly evaluate the sufficiency of the cover design.

In addition, Atlas may not have chosen the appropriate flow regime for the HEC-2 model simulations. Once again, NRC staff has accepted Atlas' conclusions without sufficient underlying data and without any independent analysis. Water surface profiles should begin at a cross-section of known elevation or starting conditions and proceed upstream for

subcritical flow and downstream for supercritical flow. Rather than choosing a cross-section adjacent to the Atlas pile, NRC staff used a downstream cross-section. Therefore, the supercritical flow, the flow downstream of the starting cross-section, would not "see" the upstream control at the Portal. NRC staff should verify that Atlas used the correct flow regime in the HEC-2 model simulations for segments of the stream profile adjacent to the Atlas Site. In sum, NRC staff used non-conservative assumptions to calculate flood flows past the Atlas Site. NRC staff's improper use of the HEC-2 model underestimates the impact of the PMF on the tailings impoundment. Without more conservative modeling, NRC staff cannot determine whether the proposed design will protect the tailings.

NRC staff must address the numerous threats from the Colorado River to long-term stability. For example, channel migration of the Colorado River is a serious threat to the long-term stability of the Atlas pile; NRC staff has inappropriately accepted Atlas' conclusion to the contrary. (DTER, p. 4-13.) NRC staff expresses concern "that there is a potential for the Colorado River to migrate and possibly reach the toe of the reclaimed tailings disposal area." (DTER, p. 4-13.) NRC staff also admits that, "because quantitative proof of bank stability was not provided, it is prudent to design the pile for such an occurrence." (DTER, p. 4-13 to 4-14.) Even in the DEIS, the NRC admits that it is uncertain whether the river will migrate in its statement that "the potential for lateral migration <u>may be</u> low." (DEIS, p. 3-17, emphasis added.) Despite this concern and uncertainty, in the DTER the staff concludes "that it is unlikely that the river will migrate as far as the tailings pile within the next 200-1000 years." (DTER, p. 4-13.) Once again, NRC staff fails to take a conservative approach to evaluating threats to the integrity of the pile.

NRC staff's dismissal of the Colorado River's migration potential is contradicted by the evidence. Grand County Council has aerial photographs which indisputably show that in the <u>last 20 years</u> the Colorado River has migrated <u>100 feet closer</u> to the Atlas pile.[8] Thus, the Colorado River's westward migration is a real, not a hypothetical event. Moreover, these photographs reveal that, in contrast to the river's current condition, in 1950, there was no vegetation on either side of the Colorado River. Since 1950, tamarisk has grown on both sides of the river, but is especially dense on the east bank/Moab slough side of the river. The dense tamarisk stand increases the river's propensity for westward

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[8] Grand County Council's aerial photographs are available for inspection by NRC staff at staff's convenience.

migration, particularly in flood events, where the gentle slope at the toe of the pile is a more attractive channel for river water than the dense tamarisk stand.

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Not only is NRC staff's conclusion regarding river migration unsupported by the facts, but NRC staff's cited reasons for its acceptance of Atlas' conclusion are deficient. First, the fact that a stream or incised channel is aggrading or actively eroding is not relevant to the context of extreme events such as the 500-year flood or the PMF. (See DTER, p. 4-13.) High water levels and flow velocities can cause channel migration regardless of the current depositional or erosional characteristics of a stream. Finally, mid-channel bars are often scoured away completely during extreme floods so that velocities near the Atlas Site would not necessarily be low and would not necessarily cause deposition. Conversely, these river flows would tend to threaten the stability of the pile.

38 TL

In the event that the Colorado River migrates toward the pile, the stability of the pile cannot be ensured regardless of the erosion protection features of the pile. Indeed, for Title I sites, the NRC recognized this hazard. For example, NRC required that the Gunnison tailings pile be moved because it was located ½-mile from the Gunnison River. The threat of potential river migration to the stability of the Gunnison pile was sufficient justification for requiring its removal. Given that the Colorado River is currently migrating towards the Atlas pile, NRC staff has no basis for not requiring similar erosion protection at Atlas' Title II site. NRC staff's acceptance of the Atlas proposal is inconsistent with its previous position for other sites located near rivers.

Moreover, the NRC cannot name a single Title I tailings pile which it has allowed to be reclaimed in a 100-year floodplain or within a PMF floodplain. For example, DOE has moved piles at Gunnison, Rifle, Slick Rock, Naturita, and Grand Junction, all of which were in PMF floodplains. Similarly, NRC staff should require Atlas to move this tailings pile out of the 100-year and PMF floodplains.

39 TL

To be "prudent," Atlas has proposed to accommodate Colorado River migration by building a wall of rock which can collapse into the Colorado River. (DTER, p. 4-13.) This rock is proposed to be an average diameter of 11.2 inches. (DTER, p. 4-19.) Atlas hypothesizes, and NRC staff accepts, that rock of this size, dropping into the river as it is carried by overland flows, will be sufficient to protect the pile from the Colorado River. However, the Colorado River, in flood conditions, is unlikely to be deterred by such relatively small rocks, even if, by chance, they happened to fall where Atlas guesses they will fall. It is more likely

that these falling rocks will create turbulence, and perhaps a rapid, at the foot of the pile, increasing the likelihood of erosion.

NRC staff simply has not required Atlas to comply with the criteria requiring that the waste pile be designed to protect against surface water erosion. Atlas' plan cannot be approved until, if ever, this deficiency is corrected.

C. <u>Erosion Protection</u> (§ 4.5.)

NRC staff's evaluation of the erosion protection features, or lack thereof, in the Atlas design is deficient in at least three respects.

<u>First</u>, NRC staff provides no support for its acceptance of Atlas' oral commitment that it will be able to locate a borrow site for the large-diameter, durable rock that will be required at this site. NRC staff is well aware of the difficulties of obtaining durable rock for use at Title I sites. At the Slick Rock, Colorado site, for example, contractors were unable to find the quantity of rock which would meet durability and cover design requirements. Therefore, the Slick Rock design had to be changed to require below-grade disposal which would use fewer rocks. NRC's experience on this issue reveals that Atlas' promise to provide durable rock is little more than a wish and a prayer. Indeed, in light of Atlas' recent retreat from its attempt to use Castle Valley rock, Atlas will have to wish and pray harder. NRC staff evaluation of this important erosion protection issue, including the cost of bringing in the riprap, should be based on reality and Atlas' firm commitments, not fantasy and Atlas' promises.

<u>Second</u>, NRC staff apparently does not recognize that rock with a nominal diameter of 1.3 inches is difficult, if not impossible, to construct in a layer of 4 inches. At Title I disposal cells, 6 inches is the minimum thickness for an erosion protection layer with a nominal rock diameter of 1.0 to 1.5 inches.

<u>Finally</u>, NRC staff recommends that Atlas be allowed to use rock with a composite durability score of between 50 and 65 for some erosion protection features. NRC staff does not disclose that rock with a durability rating of less than 65 has never been used to construct any component of the cover for a Title I waste pile. NRC's strict prohibition of <65 durability rock has even been applied to the top and side slopes of Title I sites. Once again, NRC staff does not explain why the Grand County community is not entitled to the same health, safety, and environmental protections as the communities near all Title I sites.

In sum, NRC staff underestimates the impacts from surface water on the tailings pile. The Atlas tailings pile is the only pile which the NRC is willing to leave in a floodplain. NRC staff improperly accepts Atlas' proposed plan without fully considering the serious threats to long-term stability from the surface water. NRC staff's unquestioning acceptance of Atlas' conclusions directly contradicts its guidelines which require underlying information to be sufficiently complete to allow an independent evaluation by NRC staff. (SRP, p. 30.) Thus, the DTER should be withdrawn until these deficiencies can be corrected.

V. NRC Staff Inadequately Addresses Water Resources Protection at the Atlas Site.

A. Introduction (DTER, § 5.1.)

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NRC staff fails to address site-specific hydrologic information on groundwater and surface water systems. NRC staff is obligated to study the full hydrology of the Atlas Site to evaluate the impact of the Atlas plan on water resources. (SRP, p. 39.) However, instead of thoroughly studying these issues, NRC staff ignores Criteria 5, 7, and 13, which directly apply to water quality and groundwater protection. NRC staff claims that it will consider groundwater reclamation separately from surface reclamation in evaluating compliance with NRC regulations because remediating groundwater will take longer. (DTER, p. 5-1 to 5-2.) However, NRC staff's decision to separate the groundwater compliance strategy from the tailings reclamation proposal has no legal or logical basis. Although NRC policies allow Atlas to defer implementation of groundwater clean-up, there is no statutory, regulatory, or other authority permitting the NRC to defer collecting and thoroughly analyzing data describing the impact of the Atlas pile on water resources. Indeed, it only makes sense to require NRC staff to analyze water resource impacts before surface reclamation plans are approved. Early analysis of water resource impacts may allow Atlas to improve its surface reclamation plan to protect those resources. Once surface reclamation is in place, Atlas may argue that further water resource protection is not possible. After reclamation, Atlas may argue that actions which are now possible to implement to protect water resources have become "impracticable."

By severing consideration of water quality issues, not only does NRC staff's approach violate NRC regulations and policies, but this approach makes it virtually impossible for NRC staff to evaluate thoroughly the remaining criteria, even as they relate solely to surface reclamation. For example,

NRC staff cannot evaluate the adequacy of the proposed cover because the permeability of the cover directly impacts the quantity of hazardous constituents leaving the pile.

Furthermore, the analysis of the impact of the pile on water quality should not be separated from this analysis because Atlas intends to use the design aspects of the tailings cover in order to meet groundwater protection standards. (Response to Open Issues No. 15, 16, 17, Feb. 7, 1996, pp. 6-7.) Specifically, Atlas intends to rely on three aspects of the cover design to meet groundwater protection standards: the steep side slopes of 10h:3v (which violate Criterion 4), channels on the cover surface, and the permeability of certain cover materials such as Mancos shale. (Response to Open Issues No. 15, 16, 17, Feb. 7, 1996, pp. 6-7.) Thus, understanding the current condition of groundwater in the area of the tailings pile and the continuing impact of the pile on groundwater is crucial to evaluating the cover design, as well as to both the short-term and long-term effects of in-place tailings reclamation.

B. Hydrogeologic Characterization (DTER, § 5 2.)

NRC staff's analysis of the hydrogeologic conditions of the Atlas Site is incomplete and fails to meet NRC's regulations and guidelines. Criterion 5 requires NRC staff to consider the characteristics of the waste, the hydrogeological characteristics of the area, the groundwater flow, the current and future uses of groundwater, as well as the potential risks to human health, wildlife, and vegetation. Similarly, the NRC's Final Standard Review Plan provides that the site characterization must assess "both quantitative and qualitative estimates of the impact to humans and the environment from any existing and potential groundwater contamination." (SRP, p. 39.) Furthermore, according to NRC policy, the hydrogeologic characterization "is the primary site characterization component that is used to evaluate whether the proposed remedial actions will comply with the EPA ground-water protection standards." (SRP, p. 44.) Rather than adhering to these standards and analyzing the Atlas Site's impact on groundwater, NRC staff has unquestioningly accepted Atlas' conclusions that the impacts of the tailings leachate on water resources are insignificant. (DTER, p. 5-16.)

1. Background Water Quality

NRC staff has failed to analyze adequately the background water quality despite the fact that the NRC's review plan states that "an adequate characterization of the background ground-water quality is fundamental to the assessment of the existing ground-water contamination."

(SRP, p. 48.) NRC staff should review and discuss maps illustrating monitoring locations, descriptions of monitoring devices, distribution of contaminated materials, historical changes in flow, laboratory data for hazard constituents and indicator parameters, assessments of variations in water quality, identification of off-site sources, and quality assurance of sampling. (SRP, p. 48-49.) In addition, NRC staff has only collected or presented data for selenium, combined radium-226 and -228, uranium, and total dissolved solids, and not for the full panoply of expected contaminants. (DTER, p. 5-10.) Furthermore, any analysis of this data is questionable because the background well AMM-1 may be influenced by contaminants from the former ore storage pad. We agree that this is an open issue and, if this issue is not resolved, NRC staff cannot evaluate the true extent of contamination. Not only has NRC staff has failed to review sufficient data, but the limited data which NRC staff has reviewed clearly establishes that the levels of contaminants exceed water quality standards.

2. Contaminant Characterization

NRC staff has inadequately analyzed the tailings leachate in order to evaluate the presence of all possible contaminants. NRC staff has failed to collect representative samples; those samples that were collected were not tested for all the possible constituents. Specifically, the list of constituents in Table 5-2 does not indicate which species of uranium was tested. Table 5-2 does not include any analysis of gross alpha or radon. The data in Table 5-2 also is inconsistent with the data in Table 2.1-3 of the DEIS.[7] NRC staff must verify that the data in these tables is valid and explain the sampling and analysis protocol in order to demonstrate that the sample sizes are statistically representative.

Also, NRC staff must verify that the monitoring wells were properly constructed. For example, at one Title I site, in Falls City, Texas, NRC staff rejected several monitoring wells because they were improperly constructed. If these wells are not properly constructed, the sampling data will be skewed.

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[7] The two tables should show identical data, yet they do not. (See DTER, p. 5-13 and DEIS, p. 2-8.) Which table is correct? Which data should be relied on? How have these errors affected NRC's conclusions? NRC staff should answer these basic questions about inconsistencies within NRC's own documents.

3. Extent of Contamination

Another serious deficiency in NRC staff's analysis of water resources is its analysis of the extent of groundwater contamination. In the Title I program, the NRC requires DOE to study the extent of existing groundwater contamination, even when DOE proposes to defer groundwater clean-up. (SRP, p. 48.) The NRC also requires that this analysis be based on an adequate number of sampling locations and sampling episodes to support the characterization. (SRP, p. 49.) Moreover, when verifying DOE's study of groundwater contamination, NRC staff looks to the adequacy of the number of wells, suitability of well locations, appropriateness of screened intervals, and appropriateness of constituents included in the analysis. (SRP, p. 49-50.) Yet, in the proposed Atlas reclamation, the NRC completely ignores these requirements. Although the NRC required Title I sites to meet these expectations, NRC staff fails to apply these standards to its own or Atlas' analyses. NRC staff's analysis is particularly inadequate for several reasons.

First, NRC staff fails to provide data showing which constituents have migrated from the pile and which constituents exceed standards at each monitoring station. In fact, NRC staff only provides data for one constituent, total dissolved solids. (DTER, p. 5-11, Tables 5-3, 5-4.) Table 5-9 is incomplete because there are many hazardous constituents identified in the pile which are not analyzed. For example, Atlas should monitor for arsenic, cadmium, chromium, and other heavy metals because these constituents were reported at elevated concentrations in the tailings fluid. Finally, NRC staff must verify that the data in these tables is valid, including whether the sample sizes are statistically representative. 46 MC

Second, NRC staff improperly accepts Atlas' conclusion that "the vertical extent of contamination is restricted to the relatively fresh groundwater within the upper portion of the alluvial aquifer." (DTER, p. 5-15.) However, NRC staff does not provide a sufficient basis to support this statement. Rather NRC staff reaches this conclusion merely by comparing water quality at various depths. (DTER, p. 5-15.) NRC staff does not include any of this data in the DTER, nor does NRC staff verify this data. Accordingly, this issue of vertical extent of contamination should be considered another open issue. 47 M

Third, NRC staff has not adequately examined the quality of surface water near the tailings pile.[8] There are many constituents identified in the tailings pile in Table 5-2 which were not tested in the surface water samples. Also, contrary to a statement on page 5-15 of the DTER, Figure 5-1 does not indicate the locations where surface water was sampled. Without these sampling locations, the information in Tables 5-5 and 5-6 is essentially useless.

4. Water Use

The analysis of water use in the area is inaccurate because it is outdated. The study on which the DTER relies was conducted in 1989. During the last 7 years, there has been an influx of tourists and new residents, which necessitate a new water use inventory.

In sum, NRC staff has not adequately evaluated the quality of groundwater and surface water in the vicinity of the tailings pile. Although NRC staff has decided to separate water resources remediation from the surface reclamation, NRC staff must, at a minimum, evaluate the current condition of water resources and the impact of the waste pile on these resources. Without this information, NRC staff cannot evaluate whether the surface reclamation, such as cover design, meets the Appendix A criteria. Groundwater and surface water quality will not be adequately protected if NRC staff allows Atlas to cap the tailings pile in place before considering the impact to water quality.

C. Groundwater Protection Standards and Regulatory Requirements (DTER, § 5.4.)

As discussed above, NRC staff has improperly separated an analysis of groundwater impacts and remediation from this analysis of Atlas' reclamation plan. Accordingly, NRC staff omits any analysis of Criteria 5 and 13, which require that the proposed disposal design must assure compliance with groundwater protection standards. In spite of this improper approach, in the DTER, NRC staff attempts to explain its review of Atlas' proposed corrective action program. (DTER, § 5.4.) NRC staff's summary reveals the inadequacy of its review of Atlas' corrective action plan and underscores the necessity of requiring a full, public analysis of Atlas' plan to impose perpetual contamination on the groundwater and surface water.

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[8] In evaluating the Atlas proposal, NRC staff ignored the suggestions of the Department of the Interior, a cooperating agency in the DEIS process, regarding the sampling protocol for the Colorado River.

Grand County Council, in its response to the DEIS, criticized several aspects of NRC's poor analysis of groundwater contamination and the impact of tailings leachate on groundwater and surface water. Those comments should be considered incorporated in this response to the DTER. In summary, NRC staff's conclusions that there are no potential health impacts from Atlas' tailings leachate is not supported by adequate investigation or appropriate analysis.

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Despite the inadequate testing program, NRC staff admits that it has accepted Atlas' conclusion that there is only one acceptable plan for dealing with the tailings leachate and resulting groundwater, surface water, and sediment contamination. Not surprisingly, that "corrective" action plan is to allow Atlas to construct its cover and let the pile leak for eternity. (DTER, p. 5-21.)

52 MCL

It also is not surprising to learn that the sole basis for NRC staff's acceptance of Atlas' groundwater contamination plan is that any other plan would cost Atlas too much. (DTER, p. 5-21.) Nowhere in the DTER does NRC staff explain how they conducted the cost-benefit analysis necessary to determine that Atlas' plan was preferable. Indeed, it is hard to imagine that any such analysis was conducted since NRC staff apparently accepted Atlas groundwater contamination plan before NRC's DEIS was performed. The DEIS was NRC's first, albeit flawed, attempt to analyze the environmental costs and or benefits of Atlas' reclamation plan. Thus, NRC staff would not have had information on environmental costs benefits when it supposedly determined that all other groundwater protection plans were "unreasonably costly, when comparing the risks to benefits." (DTER, p. 5-21.)[2] NRC staff has acted in dereliction of its duty to protect the public health and safety and the environment by its ill-considered acceptance of Atlas' groundwater contamination plan. NRC staff's inappropriate acceptance of Atlas' position underscores the necessity of bringing the evaluation of Atlas' compliance with all groundwater protection standards back into the public TER process.

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[2] The NRC should not conclude that Grand County Council is endorsing the cost-benefit analysis appearing in the DEIS. However, NRC staff must be held accountable for not even attempting an environmental cost-benefit analysis when it used protection of Atlas' pocketbook as its regulatory yardstick.

D. Cleanup and Control of Existing Contamination (DTER, § 5.5.)

NRC policy provides that "implementation of ground-water cleanup may be deferred to a later project phase, as long as the delay does not impact human health or the environment in the vicinity of the processing site." (SRP, p. 40.) NRC staff's severance of water resources protection from the analysis of surface reclamation violates this guideline in two respects. First, NRC staff has severed more than the implementation phase of groundwater remediation. NRC staff has also severed from consideration its analysis of the background water quality, the nature of the leachate, and the extent and flow of contaminants from the tailings to the alluvial aquifer and surface water. NRC staff's decision is not authorized by the guidelines and violates NRC's regulations. Second, NRC staff has not shown that the delay in implementation of groundwater remediation plans will not impact human health or the environment at the Atlas Site.

VI. Radon Attenuation and Site Cleanup.

NRC staff has identified a number of inadequacies in Atlas's sampling program, as well as uncertainties in the method for differentiating affected soil from unaffected soil. Based on these inadequacies, NRC staff concluded that the long-term radon flux standard and other cover requirements of Criterion 6 had not been achieved. NRC staff's evaluation does not go far enough. The Atlas plan is so riddled with inaccuracies and inconsistencies that it should be rejected in its entirety. Atlas should be required to submit a new plan that complies with all applicable radon attenuation licensing criteria.

A. Characterization of Materials (DTER, § 6.2.1.)

In this section of the DTER, NRC staff acknowledges that it has concerns "regarding the limited number and composition" of the samples taken by Atlas. (DTER, p. 6-2.) However, NRC staff's concern is an understatement at best. Atlas performed a total of six test borings on the top slope of the tailings pile to depths of 8 feet. The borings were grouped according to material types: ore (3 samples), coarse sand tailings (16 samples), and fine tailings (12 samples). (DTER, p. 6-2.) This limited number of samples (31) is wholly inadequate to characterize the composition of the tailings pile or the cover materials, given that the overall size of the disposal cell is approximately 130 acres.

In contrast to Atlas's slapdash approach to characterizing the disposal cell, the UMTRA Title I Project has an established procedure whereby 20 boreholes at

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uniformly spaced locations are drilled to a depth of at least 16 feet of the tailings (as compared to the 8 feet used by Atlas).[10] Radiological analyses are then required to be performed for every 2-foot interval, for a total of at least 160 radiological data points (as compared to the 31 conducted by Atlas). These samples must then analyzed for both Ra-226 and Th-230. The UMTRA Title I Project designs its cover thickness depending on the more restrictive value of either Ra-226 concentration today or the Ra-226 that will exist in 1000 years (based on the decay of Ra-226 currently present plus that which will grow from the Th-230). Both NRC staff and the Atlas proposal fail to analyze for the presence of Th-230, an oversight that could lead to seriously underestimating the radon flux and the thickness of the cover. 55 ESB 56 ESB

The failure of Atlas to sample for Th-230 also raises issues relating to sub-pile or sub-raffinate pond soils. When the sub-pile soils with high Th-230 concentrations are placed on the top of a disposal cell as part of final contouring, it creates an unacceptable long-term design, as was the case with several UMTRA Project sites such as Ambrosia Lake, New Mexico, and Riverton, Wyoming. NRC staff's failure to address off-pile Th-230 sources constitutes another open issue that should have been addressed. 57 ESB

Table 6-1 identifies another problem with the limited sampling performed by Atlas at the site. This table presents radon flux values that will arise from areas of the pile that contain fine tailings (19.8 $pCi/m^2/s$), coarse tailings (18.5 $pCi/m^2/s$), and sideslopes (19.15 $pCi/m^2/s$). Each of these values is dangerously close to the 20 $pCi/m^2/s$ standard applicable to such values. If the tailings characterization is not representative of the pile, which it is not, then the radon flux could, in fact, far exceed the design standard. 58 ESB

In sum, the information presented by Atlas is simply inadequate to provide a "reasonable assurance" that the available radiological data can be used to prepare an acceptable cover design to limit the radon flux to less than 20 $pCi/m^2/s$. Atlas's test methods, and NRC staff's partial approval of those methods, does not constitute a technically defensible approach to radon attenuation cover design.

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[10] This requirement conforms with NRC staff's own conclusion that the Atlas boreholes should have been drilled to at least "15 feet." (DTER, p. 6-2.)

B. Parameters for Contaminated Materials
(DTER, § 6.2.2.)

NRC staff has identified an "open issue" and a "confirmatory item" relating to the Atlas sampling plan for contaminated materials. (DTER, pp. 6-5 to 6-6.) The open issue relates to Atlas's failure to properly sample for Ra-226 values in coarse tailings, as well as to its assumption that all coarse tailings on the sideslopes are homogeneous. (DTER, p. 6-5.) The confirmatory item relates to Atlas's proposal to sample for contaminated soil during construction. (DTER, p. 6-6.) Both items are illustrative of Atlas' consistent failure to properly characterize the tailings pile and its unproven "commitment" to sample for the necessary parameters in the future.

The Title I Project has established a method for performing a "sensitivity analysis" on cover designs that ensures that incomplete data elements used in the cover design are identified and addressed. (See Technical Approach Document, UMTRA-DOE/AL 050425.0002, Dec. 1989). However, Atlas has failed to provide any assurance that it will evaluate the proper parameters during construction. Although this item has been labelled as "confirmatory," this item should be considered open. Indeed, the unanswered question here is, if Atlas is unable to properly characterize the tailings pile before obtaining approval for its plan, what assurance is there that Atlas will properly sample after the plan is approved?

C. Parameters for Radon Barrier Soils (DTER, § 6.2.3.)

NRC staff identified an open issue about the manner in which Atlas determined the background concentration of Ra-226 in Moab Wash soils. (DTER, p. 6-9.) The sampling of background concentrations by Atlas is problematic in two critical respects. First, it raises the question of whether potentially contaminated soil from Moab Wash could be placed on top of the disposal cell as cover material, regardless of its Ra-226 concentration, merely because it represents "background" for the area and can be ignored for design purposes. This is an unacceptable result from any perspective, particularly that of public health and safety.

Second, the cleanup criterion for Moab Wash depends on the designated background value for Ra-226 for the region. If Atlas proceeds with its plan to test for background in the same Wash area that it proposes to clean up, it will lead to elevated levels of Ra-226 remaining in the Wash. In comparison, the UMTRA Title I Project determines background concentrations by taking at least 5 borings 5 to 6 feet in depth from areas that are near the sites, but that are

otherwise uncontaminated by tailings materials (unlike the Moab Wash). These borings are analyzed for Ra-226 at 1-foot (sometimes 6-inch) intervals for a total of 25 to 60 data points in order to describe accurately the mean background concentration and its variability. Atlas' failure to conduct proper background sampling simply underscores the scientific and technical problems at this site.

NRC staff also identified a confirmatory item and an open issue with respect to the proposed clay borrow materials. (DTER, p. 6-8.) NRC staff acknowledges that, once again, Atlas has failed to properly characterize materials to be used at the site. (DTER, p. 6-8.) Although NRC staff appears to be comfortable with allowing Atlas to confirm the properties of the clay borrow material at some time in the future, this should be considered an open issue.

Moreover, any diffusion coefficient tests that are performed with respect to the clay borrow materials should be conducted in a manner consistent with the Title I Technical Approach Document. The sensitivity analysis recommended earlier will emphasize the need to determine more accurately the cover material's diffusion coefficient. Without a sensitivity analysis, any determination of the cover material's diffusion coefficient is likely to be underestimated by Atlas and, thus, not sufficiently considered by NRC staff.

D. <u>Durability of the Radon Barrier</u> (DTER, § 6.4.)

NRC staff incorrectly concludes that the cover is unlikely to be significantly disrupted by burrowing animals or deep-rooted plants. (DTER, p. 6-11.) This conclusion is unfounded. First, the proposed 4-inch rock layer is totally inadequate to preclude permanent germination and growth of plants, especially invasive and aggressive, deep-rooted plants such as salt cedar (<u>i.e.</u>, tamarisk). This inadequacy has been clearly demonstrated at the Shiprock Title I site where salt cedar grew in rock armor 6 to 8 inches thick. Likewise, such rock armor has not deterred small animals from burrowing into the pile.

This problem is particularly relevant at the Atlas Site because a stand of tamarisk is found directly adjacent to the pile. As Grand County Council discussed in its response to the DEIS, the local tamarisk has great potential for disrupting the pile's cover. Given that 6 to 8 inches of rock armor at Shiprock were insufficient to preclude salt cedar growth and burrowing animals, it is absurd to conclude that the 4-inch cover at the Atlas pile will.

In addition, because the Moab area is subject to considerable amounts of blowing sand, it is a foregone conclusion that the interstices of the rock armor will be filled with varying degrees of sand and, thus, will become subject to plant intrusion. Although NRC staff identifies sand dunes as an "open issue" in section 2.4.2.1., it fails to identify the same issue with respect to cover integrity. Experience at Title I sites, such as Tuba City, demonstrate that conditions favorable for plant intrusion can develop in a relatively short time and become a problem, particularly on areas of the slopes that are shaded from the sun and preserve precipitation (available for seed germination) better than other areas of the pile.

The likelihood of bio-intrusion, including that of burrowing animals, underscores another defect with the Atlas proposal. The Atlas proposal requires a large number of ongoing mitigative efforts in order to succeed. Atlas has revealed that it plans to provide only a small amount of money and leave the great majority of the cost of long-term maintenance of its waste pile to the taxpayer. The ongoing maintenance required by the Atlas proposal and Atlas' refusal to fund these requirements should be considered open issues relating to durability of the proposed radon barrier.

E. <u>Measured Radon Flux</u> (DTER, § 6.5.)

NRC staff cavalierly states that if the proposed cover fails radon flux tests after it has been completed, "staff could require corrective action such as additional radon barrier material." (DTER, p. 6-12.) This statement rests on two unsupported assumptions. First, that if Atlas's inadequate characterization of the tailings pile leads to a cover failure, it can be easily fixed by slapping on more cover. Second, that Atlas will still be around to perform the necessary corrective actions. Given NRC's own experience of the difficulties and costs of cover construction, NRC staff's acceptance of the ease of applying additional cover material is unwarranted. Furthermore, this approach to cover design flaws violates NRC regulations prohibiting long-term maintenance.

In conclusion, NRC staff's evaluation of the Atlas radon barrier design is rife with substantial omissions and unanswered questions. Atlas has failed to provide NRC staff with key information regarding the characteristics of the tailings pile, the composition of the proposed borrow clays, or the proper background concentrations of Ra-226 in Moab Wash soils. Without this information, any proposed analysis of the radon barrier design, a critical component of the Atlas proposal, is meaningless. In addition, NRC staff has failed to analyze properly the effect of bio-intrusion on the

thin rock armor of the Atlas proposal. This key oversight not only throws into question the supposed durability of the radon barrier design, but also underscores the lack of any realistic assessment of the amount of ongoing maintenance necessary for upkeep of the barrier.

VII. NRC Staff's Assessment of Compliance with Appendix A Criteria Conceals Atlas' Violation of NRC's Licensing Requirements.

NRC staff's technical expertise easily lulls one into a false belief that NRC staff has used conservative analytical techniques to insure that Atlas' plan complies with all licensing requirements. However, when NRC staff compiles all of its previous analyses and assesses whether they, in fact, establish compliance with Appendix A criteria, the overall inadequacy of the DTER is revealed.

Criterion 1 - Permanent Isolation

NRC staff admits that several of Atlas' site features do not comply with Criterion 1, which requires permanent isolation of tailings and contaminants without the need for ongoing maintenance. For example, NRC staff has not been given adequate information regarding the effects of geologic, including seismic, disturbances to conclude that active site maintenance will not be required. Although it is disturbing that the NRC had intended, three years ago, to approve Atlas' plan without this vital information, Grand County Council is relieved that the NRC now recognizes the importance of this information. We therefore expect that Atlas' response to open issues regarding geologic disturbances will be evaluated publicly, thoroughly, conservatively, and consistently with requirements imposed at Title I sites. 68 MHF

1. Remoteness from Populated Areas

However, NRC staff's conclusion that all other non-seismic aspects of Criterion 1 have been met is erroneous, on several grounds. First, in defiance of reality, NRC staff concludes that the Atlas Site is remote from populated areas. Again, NRC staff misstates the distance to Moab city limits and the residential development at those limits. The distance is 1.5 miles, not 3 miles, from the tailings pile. Since radioactive contaminants are not expected to travel by motor vehicle or bicycle, NRC staff's reference to the distance to Moab by road miles is highly misleading. Similarly, NRC staff overstates the distance between the Atlas radioactive waste pile and Arches National Park. The park is not located two miles away from the Atlas Site; rather, it is located across the street and is separated from the radioactive waste pile by only the 69 MH

width of a two-lane highway. NRC staff's deliberate dissemblance on this issue is made apparent by its failure to include Arches National Park on the only location map included in the DTER. (See DTER, p. [illegible].) Furthermore, in its discussion of recreational and tourist uses, NRC staff states, "Adjacent . . . waters are used for a variety of activities." (DTER, p. 7-1.) However, this vague description of the environment near the Site should not be used to hide the fact that this site is not just adjacent to some unnamed "waters." Rather, it is on the banks of the Colorado River -- a national treasure and a source of water, recreation, tourism, and multiple other uses by people from all over the world.

NRC staff's other attempt to mislead the reader on the "remoteness" issue reveals a subtle decision to sacrifice the health and safety of the Moab community. Apparently, to justify the licensing of the permanent siting of a radioactive waste pile in this area, NRC staff notes that the population in Moab and Grand County dropped between 1980 and 1990. However, since the last census, the population in Moab and Grand County is growing. In preparing the Grand County General Plan, the County estimates that the population will exceed 30,000 by 2020. NRC staff also ignores the influx of tourists to Arches National Park. Last year, nearly one million people visited the park, and this number is expected to increase by 7% each year.

Not only does NRC staff ignore recent surges in population growth, but it implies that it is acceptable to put in jeopardy the Grand County community's health and safety because there are only relatively few of us. Not only is this perspective insulting, but it also reveals that NRC staff does not have a true appreciation for the serious implications of its actions both for individual citizens and for the environment. NRC staff must be forced to acknowledge that, beginning on this first ground, the Atlas plan does not meet Criterion 1.

2. Isolation of Contaminants from Groundwater Sources

NRC staff concludes that Atlas' plan adequately protects groundwater from contamination, but provides no support for that conclusion. As discussed above, for reasons that have never been adequately explained, NRC staff has severed groundwater protection standards from the overall licensing requirements of the reclamation plan. Although NRC staff admits to this tactic, staff never provides any regulatory or statutory authority for using it. Deleting groundwater protection requirements from a thorough review of Atlas' plan makes no sense from a technical standpoint. As demonstrated

in the DTER and SRP, groundwater issues pervade the other issues which must be addressed for all technical disciplines, including geotechnical stability, erosion protection, water resources protection, radon attenuation, and site clean-up. (DTER, §§ 3, 4, 5, and 6.) A "thorough, focused, efficient and consistent" evaluation of the long-term impact of the Atlas plan on both the public and the environment simply cannot occur if groundwater contamination is not addressed at the same time that NRC staff considers other technical criteria. (See SRP, p. 3.) 70 MH

NRC staff reaches the conclusion that Atlas' plan for permanent groundwater contamination is acceptable without engaging in a full analysis of environmental costs and benefits, and outside of the NEPA process the NRC used to evaluate the Atlas Site. Thus, without fulfilling NEPA procedures, NRC staff impermissibly concluded that Atlas' groundwater "reclamation" plan was acceptable because it was the least costly to Atlas. Whatever the reason NRC staff may have had for trying to avoid consideration of groundwater protection in the TER process (including, perhaps, fear of public scrutiny), we sincerely expect NRC staff to change its position and to engage in a full analysis of groundwater protection as part of a thorough TER process. Until such analysis occurs, Atlas cannot show that its plan complies with this second component of Criterion 1.

3. Minimize Impact of Natural Forces

In Section VII of the DTER, NRC staff concludes that Atlas has demonstrated that the cover design will protect against erosion and dispersion by natural forces. However, this conclusion is inconsistent with NRC staff's own prior analysis of Atlas' proposal in the DTER. In the DTER, Section 4.5, NRC staff found that, because Atlas' riprap cover design had not been submitted for NRC's review, Atlas' plan was not acceptable to demonstrate adequate erosion protection. Indeed, because Atlas has no real plan for obtaining adequate rock for its cover, Atlas' plan is not ready for review in this DTER process. Furthermore, NRC staff has found Atlas' plan inadequate to protect against landslides and has named the landslide potential an "open issue." 71 MHF

Given these omissions and inadequacies in Atlas' plan, which NRC staff recognizes, NRC staff's conclusion that Atlas' design protects against erosion and disturbances by other natural forces is without merit or basis in science. NRC staff must be forced to acknowledge that, also on this third ground, the Atlas plan does not meet Criterion 1.

4. No Active Maintenance Required

The NRC staff also concludes that the tailings pile will not require active maintenance over the 1,000-year design life of the Atlas proposal because the riprap cover design is "not expected" to deteriorate significantly or be susceptible to flood damage. The NRC staff's conclusion cannot be supported on this record. As set forth above, the NRC staff has failed to account for bio-intrusion, which based on UMTRA experience, can develop in a relatively short time and cause serious disruptions to the radon barrier. Moreover, the NRC staff has seriously underestimated both the probability and impact of a PMF on the integrity of the pile. In addition, Atlas' uniquely steep slopes, lacking a clay cover, have no prior history of constructability or durability. As a result, in addition to its failure to demonstrate that the Site will not require active maintenance to mitigate the effects of geologic, including seismic, disturbances, Atlas has not demonstrated compliance with Criterion 4 on these grounds as well.

If, as directed by the express meaning of Criterion 1, NRC staff place "primary emphasis" on isolation of the tailings, particularly through "an optimization of the three siting features of remoteness from populated areas, hydrologic conditions, and resistance to erosion," NRC staff cannot determine that the Atlas plan fulfills the regulatory requirements of Appendix A. (See In the Matter of Kerr-McGee Chemical Corporation, No. 40-2061-ML, 1991 WL 204282 (N.R.C. 1991).) In Kerr-McGee, the NRC Atomic Safety and Licensing Appeal Board did not find acceptable the applicant's plan to cap in place an existing radioactive waste pile above grade, several feet over the water table, because the plan did not place "primary emphasis" on the isolation of tailings, but instead allowed them to remain in a populated area. For many of the same reasons the Kerr-McGee plan did not meet Criterion 1, the Atlas plan also does not meet Criterion 1. NRC staff, therefore, must reject the Atlas plan.

Criterion 3 - Below-grade disposal is the prime option

NRC staff's conclusion that the Atlas plan meets Criterion 3 violates NRC's statutory and regulatory obligations, especially since NRC staff's sole basis for excusing Atlas from meeting this clear licensing requirement is that a below-grade disposal would be "economically impracticable." (DTER, p. 7-3.) Although Criterion 3 requires below-grade disposal as the "prime" option, NRC staff finds that Atlas' design is acceptable even though the pile will be 110 feet above grade. However, NRC staff may only make licensing decisions in conformance with the Appendix A Criteria. As a matter of law, compliance with

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those criteria must take into account public health and safety, and the environment. Although "due consideration" must be given to economic costs, those are not to be the sole, or even primary, basis for determining compliance with Criterion 3. Thus, NRC staff simply violates the law when it states that Atlas' proposal complies with Criterion 3 because below-grade disposal costs too much.

Furthermore, NRC staff reaches this conclusion of "economic impracticability" by distorting its own published documents and by making completely unsupported conclusions about the costs involved. First, NRC staff states that, "if other criterion are met" (which itself is but a wild guess, at this point), "the benefits over stabilizing the tailings in place would be negligible." (DTER, p. 7-3.) The sole basis for this statement is a reference to the NRC's Draft Environmental Impact Statement ("DEIS"). However, in the DEIS, the NRC does not find that the benefits of moving the Atlas tailings pile to a below-grade disposal area would be "negligible." In fact, in the DEIS, the NRC concludes that moving the waste pile would be "environmentally preferable." (DEIS, p. 2-26.) The NRC also concludes that the Atlas plan has "significant, long-term impacts" to the environment. (DEIS, p. 2-25.) In addition, the NRC reports that, as compared to the Atlas Site, the below-grade alternative, the Plateau site, better complies with all the Appendix A licensing criteria. (DEIS, p. 2-26.) Thus, NRC staff's conclusion that the benefits of below-grade disposal are "negligible" is flatly and repeatedly contradicted by the NRC's own conclusions in the DEIS.

In the DTER, not only does NRC staff ignore the conclusions in the DEIS, but NRC staff also then relies upon one further other unsupported assumption in justifying its erroneous conclusion that the Atlas plan complies with Criterion 3. NRC staff states that the cost of moving the pile to a below-grade facility would be "much greater than the benefit realized, making relocation economically impracticable." (DTER, p. 7-3.) However, this statement is not the result of a focused, documented, or credible analysis. (See SRP, p. 3.) Nowhere in the entire DTER does NRC staff engage in any analysis of the cost of relocating the Atlas pile. Indeed, NRC's attempt to analyze that cost in the DEIS is inadequate and biased. (See Grand County Council's comments in response to Draft Environmental Impact Statement, April 29, 1996, Part V.) Nor does NRC staff analyze the benefit to public health and safety and to the environment which will be realized when the Atlas pile is moved to a below-grade disposal cell. Without having analyzed the costs or the benefits of relocation, NRC staff's conclusion that the costs of relocation are "much greater" than the benefits is simply polemical. (DTER, p. 7-3.) This

conclusion, unsupported by fact or analysis, serves only to reveal NRC's unwavering bias in Atlas' favor.

Criterion 4 - Technical Disposal Criteria

Criterion 4(a) - Flood and water erosion protection

NRC staff's conclusion that Atlas' plan will provide erosion protection is contradicted by its analysis in Section 4.5 of the DTER. As discussed in response to Criterion 1, NRC staff has found that the issue of erosion protection is an open one. Thus, until Atlas has a practicable plan for providing riprap and other erosion protection features, Atlas has not demonstrated compliance with Criterion 4. 75 NHF

Criterion 4(b) - Wind and erosion protection

NRC staff concludes that Atlas' plan protects against wind erosion because it finds that riprap which can withstand water erosion can stand up to wind erosion. However, as discussed repeatedly above, NRC staff is in error when it concludes that Atlas' plan protects against water erosion. Thus, because Atlas' plan does not protect against cither water or wind protection, the plan does not meet Criterion 4(b). 76 MHF

Criteria 5, 7 and 13 - Ground Water Protection

Grand County Council's comments in response to NRC staff's conclusions with regard to Criterion 1(a) apply with equal force to NRC staff's evaluation of Criteria 5, 7 and 13. Again, without any basis in the law or regulations, NRC staff bifurcates groundwater protection issues from its evaluation of Atlas' plan in this TER process. As in NRC's approach to Title I sites, Atlas should be required to prove now how it will address groundwater contamination. The projected costs of necessary groundwater protection measures should be included in Atlas' costs for licensing compliance. No element of the reclamation plan should be approved unless it is shown to comply with groundwater protection standards. Approving of pieces of the Atlas plan now, before groundwater protection is addressed, may lead to unnecessary costs -- to Atlas, to public health and safety, and to the environment. Thus, to comply with NRC's statutory and regulatory mandates, NRC staff should be required to include the full evaluation of groundwater protection in its current TER process. MHF

Criterion 6 - Performance Criteria

Criterion 6 sets forth the performance criteria for the disposal of tailings. Criterion 6(1) requires that waste 78 M

disposal areas be closed in accordance with a design which provides "reasonable assurance" that the average releases of radon-222 and radon-220 to the atmosphere will be limited to 20 pCi/m^2s. The design is to be effective for 1,000 years to the extent reasonably achievable and, in any case, for at least 200 years. For the reasons discussed throughout these comments, the Atlas proposal does not provide a reasonable assurance that the tailings pile will be effective at all, let alone for 200 years, much less for 1000 years. (78) MH

As NRC staff correctly notes in the DTER, Atlas has failed to provide the NRC with sufficient data relating to the characteristics of the pile, the background concentrations of Ra-226 in the vicinity of the pile (see also Criterion 6(5)), or the properties of the proposed cover material. In fact, NRC staff is hard-pressed to identify any Atlas sampling data upon which it can determine whether the proposed radon barrier will actually work. These open issues should preclude the Atlas proposal from any type of serious consideration, let alone approval.

NRC staff also fails to adequately address the issue of bio-intrusion on the durability of the radon barrier. Contrary to NRC staff's unsupported conclusion that bio-intrusion is not an a serious problem at the Site (DTER, p. 6-11), prior NRC experience has demonstrated that vegetated growth and burrowing animals have disrupted cover designs at Title I sites with rock covers twice as thick as that proposed at the Atlas Site. (See, UMTRA-DOE/AL 40067.0000, Vegetative Growth Patterns on Six Rock-Covered UMTRA Project Disposal Cells, Feb. 1992; DOE/AL/62350-200, Rev. 1, UMTRA Project Disposal Cell Cover Biointrusion Sensitivity Assessment, Oct. 1995.) The NRC's blithe disregard of this known, serious problem constitutes a fundamental failing of the DTER.

Criterion 12 - No Ongoing Maintenance (79) MI

As set forth above in response to Criterion 1(4), the NRC staff's conclusion that no ongoing active maintenance is required to preserve the radon barrier at Atlas Site cannot be supported on this record. Not only does NRC staff ignore the effects of bio-intrusion, but it also seriously underestimates the impact of a PMF and of the unique and questionable cover design on the integrity of the pile. As a result, Atlas also cannot demonstrate compliance with Criterion 12.

CONCLUSION

At some point in this regulatory process, the NRC and its staff must address the real public policy issue presented by the Atlas Site. The NRC must decide whether Atlas' plan is the best plan for the permanent disposal of 10.5 million tons of radioactive waste. In issuing the DEIS, the NRC took two steps forward in answering that question. First, it determines that the Atlas Site presents many adverse, long-term environmental impacts and that the alternative of moving the pile presented no long-term adverse environmental impacts. (See DEIS, pp. 2-25, 2-26.) Second, the NRC finds that the Plateau Site Alternative complies more fully with the Appendix A technical licensing criteria than does the Atlas plan. (DEIS, p. 2-26.) Unfortunately, the NRC also takes a giant step backward in its decision-making, when it concludes that, because of the "estimated" costs to Atlas of moving the pile, the Atlas plan is "acceptable with respect to environmental costs and benefits." (DEIS, p. xxi.)

The NRC reaches its decision that the Atlas plan is environmentally acceptable because it gives inappropriate weight to Atlas' financial interests. The NRC excuses its lack of concern for the adverse environmental consequences of the Atlas plan by stating that NRC staff's TER review will insure that these adverse consequences are eliminated. (See, e.g., DEIS, pp. 2-6, 2-13.) As demonstrated above, the TER process thus far has not insured that Atlas has eliminated adverse environmental consequences. Instead, NRC staff has attempted to exempt Atlas from several of the licensing criteria and has done so by not conducting a DTER analysis which complies with the NRC's policies.

Grand County Council expects NRC staff to respond to these criticisms by stating that its only role is to evaluate whether Atlas' plan complies with the regulations, not whether it is the best plan. However, NRC staff demonstrates that it is doing more than dispassionately evaluating technical criteria when it excuses Atlas from strict compliance with regulatory criteria; fails to conduct a thorough and conservative review of Atlas' plan, pursuant to its own policies; accepts Atlas' assumptions, estimates, and promises at face value, without sufficient scrutiny; and acts inconsistently with the NRC's previous decisions at Title I sites. Thus, NRC staff is not conducting an objective exercise in technical analysis. Instead, NRC staff is using the DTER to impermissibly weight the scales in favor of Atlas' plan.

Moreover, even if the choice of a reclamation plan were simply a matter of dollars and cents, the DTER reveals that the necessary calculations have not been made. Despite NRC staff's attempts to hide this conclusion, it is apparent that Atlas' plan, even from a narrow technical standpoint, is

filled with current and future problems. Its current location requires the pile to have unacceptably steep slopes. The pile will always be threatened by floods, landslides, and bio-intrusion. Moreover, the plan currently calls for perpetual groundwater contamination. Finally, the pile is located in an area central to tourism, recreation, and new residential development. It is hard to imagine how, absent a 24-hour security guard, Atlas intends to prevent human intrusion at this prominent location. Thus, Atlas and NRC staff have underestimated the cost of current construction and future maintenance and have ignored all costs of environmental consequences.

Congress found that uranium mill tailings "may pose a potential and significant radiation health hazard to the public." (SRP, p. 1 (citing UMTRCA).) Therefore, Congress determined "that every reasonable effort should be made to provide for stabilization, disposal, and control in a safe and environmentally sound manner of such tailings in order to prevent or minimize radon diffusion into the environment and to prevent or minimize other environmental hazards from such tailings." (Id.) NRC staff has not completed this DTER review in accordance with its obligation to conduct its "domestic licensing . . . functions in a manner which is both receptive to environmental concerns and consistent with the [NRC's] responsibility . . . for protecting the radiological health and safety of the public." (10 C.F.R. § 51.10.) Instead, NRC staff's review attempts to obscure and excuse the fact that Atlas' plan is an unreasonable, costly, and unacceptable final reclamation plan. Thus, we urge NRC staff to withdraw the conclusions reached in the DTER and require Atlas to propose a new plan which will eliminate the long-term adverse environmental consequences by moving the tailings pile to a location which will comply with the NRC's licensing requirements.

Respectfully submitted,

GRAND COUNTY COUNCIL

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40-3453

April 26, 1996

Mr. Joseph Holonich
Chief, High Level Waste and Uranium Recovery Projects Branch
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U.S. Nuclear Regulatory Commission
Washington, D.C. 20555-0001

Re: **State of Utah Comments.** Nuclear Regulatory Commission (NRC) January, 1996 Draft Environmental Impact Statement Related to Reclamation of the Uranium Mill Tailings at the Atlas Site, Moab, Utah and Draft Technical Evaluation Report for the Proposed Revised Reclamation Plan for the Atlas Corporation Moab Mill, Source Material License No. SUA-917, Docket No. 40-3453:

Dear Mr. Holonich:

Enclosed are comments generated as a result of a review of the 1996 Draft Environmental Impact Statement (DEIS) Related to Reclamation of the Uranium Mill Tailings at the Atlas Site, Moab, Utah and the NRC Draft Technical Evaluation Report (DTER). We have appreciated the effort of the NRC to try to produce a comprehensive EIS document. We also appreciate the opportunity to review the NRC's current findings regarding the Atlas Reclamation Plan, and generally agree with all 20 of the open issues identified in the DTER.

These comments will reflect the need for NRC to address certain additional open issues not listed in the DTER. These issues should be resolved before any NRC approval of the Atlas on-site Reclamation Plan. We would also like to convey State comments and concerns regarding NRC findings listed in the DTER and DEIS. We appreciate your assistance with the Atlas project and are eager to discuss these concerns with you at your earliest convenience.

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Should you have any questions regarding our comments or would like to discuss the open issues identified. please call myself or Loren Morton of my staff at (801)536-4250.

Sincerely.

William J. Sinclair. Director
Division of Radiation Control

Enclosure

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F:DTER.LTR
FILE:ATLAS RECLAMATION PLAN

REFERENCES

Blanchard, P. J., 1990, "Ground-Water Conditions in the Grand County Area, Utah, with Emphasis on the Mill Creek - Spanish Valley Area", a USGS study completed in cooperation with the Utah Department of Natural Resources (DNR), DNR Technical Publication No. 100, 69 pp.

EnecoTech, April 28, 1988, "Technical Response for Ground Water Detection Monitoring Program, unpublished consultants report, 12 pp. plus attachments.

Western Technologies, March, 1989, "Draft/Final Atlas/Moab Uranium Mill and Tailings Corrective Action Plan Moab, Utah", consultants report, 42 pp.

U.S. Nuclear Regulatory Commission, October 21, 1987 Letter from Edward F. Hawkins to Atlas Minerals Regarding NRC Sampling and Analysis of Atlas Tailings Effluent.

DIVISION OF RADIATION CONTROL
UTAH DEPARTMENT OF ENVIRONMENTAL QUALITY

COMMENTS ON:

January, 1996
Draft Technical Evaluation Report for the
Proposed Revised Reclamation Plan for the
Atlas Corporation Moab Mill
NUREG-1532
U.S. Nuclear Regulatory Commission
Source Material License No. SUA 917
Docket No. 40-3453

by
Loren Morton
Hydrogeologist
Utah Division of Radiation Control

April 26, 1996

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EXECUTIVE SUMMARY

State review of the January, 1996 NRC Draft Technical Evaluation Report (DTER) has found significant effort has been completed by Atlas and the NRC in evaluation of technical details needed for on-site stabilization of the existing tailings embankment, as they relate to surface water hydrology and design of erosion protection features. Unfortunately, many significant shortcomings have been identified by the NRC in the areas of geologic and geotechnical stability that Atlas has not yet resolved. We agree with all 20 of the NRC open issues identified in the DTER, and strongly concur that neither the Reclamation Plan nor the engineering design for the cover can be approved without prior resolution of these open issues. Furthermore, we also believe that resolution of the NRC confirmatory issues is in order before approval of either the Reclamation Plan or the final engineering design.

During our review of the DTER, we discovered a number of State technical concerns and open issues regarding the Atlas Reclamation Plan and facility, which were not addressed by the NRC. These concerns can be grouped into 14 general categories, which are summarized below:

1. Inadequate subsurface geologic model for site.
2. Incomplete and unjustified engineering design specifications.
3. Inadequate construction quality assurance/quality control requirements.
4. Inadequate hydrogeologic characterization of both tailings pile and mill site areas.
5. Inadequate groundwater monitoring for tailings pile and mill site.
6. Need to investigate potential groundwater contamination of Arches National Park and adjoining private property.
7. Need to implement a groundwater monitoring quality assurance/quality control plan.
8. Inadequate characterization of tailings leachate characteristics.
9. Need to require groundwater monitoring for additional tailings contaminants.
10. Need to revise and justify groundwater protection standards.
11. Need to enforce NRC Criterion 5D groundwater corrective action program requirements at facility.
12. Need to investigate apparent non-radiologic contamination of the Colorado River.

13. Need to complete a performance assessment to demonstrate final engineered cover can adequately protect local groundwater and surface water resources.

14. Need to require Atlas to implement a viable groundwater corrective action program that will protect both ground and surface waters.

From our review of the DTER and water quality data collected by the State, it is apparent that historic operation of the Atlas facility has resulted in pollution of nearby groundwater and surface water resources. From review of NRC docket files it is also apparent that NRC regulation of the Atlas facility has lacked critical thinking in its efforts to protect groundwater and surface water resources. The current NRC license has failed to impose NRC Criterion 5D requirements for groundwater cleanup. Consequently, Atlas is not required to return contaminated groundwater to compliance with License groundwater protection standards. Furthermore, Atlas has made little effort to contain groundwater pollution on their property. After consideration of this lax historic oversight of the facility, it is critical that any on-site stabilization today include an thorough evaluation of the efficacy of the final engineered cover to control pollutants to acceptable levels in nearby groundwater and the Colorado River.

From material presented in the DTER, and independently by NRC staff and Atlas, it is also apparent that Atlas has not yet provided adequate characterization of geologic and hydrogeologic conditions at their facility. Critical pre-design information for many engineered materials has yet to be provided that could justify the proposed design basis for the tailings pile cover. Furthermore, Atlas has not provided adequate construction quality control measures to ensure that the tailings cover will be field constructed in compliance with any approved design.

Consequently, approval of the Reclamation Plan and any engineering design for on-site stabilization of the tailings is premature and unjustified.

As a consequence of the many and various open issues and concerns regarding the Atlas facility, the engineering design proposed by Atlas and articulated by the NRC in the January, 1996 Draft TER is incomplete and unjustified. Because of the preliminary nature of the current engineering design and the myriad of open issues present, it appears that the final design for the tailings embankment cannot be approved without prior resolution of both the NRC and State open issues.

ACKNOWLEDGEMENTS

Preparation of this report was greatly facilitated by the assistance of several people who must be acknowledged. Great insight into local geology was provided by Messrs. Helmut Doelling, Mike Ross, Gary Christenson, and Frank Ashland of the Utah Geologic Survey. Key file information was provided by Mr. Bruce Rodgers of the National Park Service, Canyonlands National Park. Helpful discussions and information were provided by Messrs. Frank Darcey and Sam Wilson of the National Park Service, Arches National Park. Historic water quality data from Arches National Park was provided by Mr. Ken Bousfield of the Utah Division of Drinking Water.

Assistance with review of engineering issues was provided by Mr. Woodrow Campbell of the Utah Division of Radiation Control. Access to key documents were provided by Messrs. Allen Mullins and Mike Layton of the U.S. Nuclear Regulatory Commission. Essential discussions of surface water quality standards for the Colorado River were provided by Mr. Steve McNeal of the Utah Division of Water Quality. Critical groundwater and surface water quality data was collected and provided by Mr. Richard Denton and his staff at the Utah Division of Water Quality, with assistance of the National Park Service.

INTRODUCTION

The purpose of this report is to document additional open issues not yet identified by the NRC and list technical concerns regarding the NRC January, 1996 Draft Technical Evaluation Report (DTER), referenced above. These open issues and comments are provided below with reference to their corresponding section in the DTER.

OPEN STATE ISSUES AND CONCERNS

Comments on Geologic Stability (Section 2.0) - preparation of these comments were closely coordinated with the Utah Geological Survey (UGS), whose original comments can be found in Attachment 1, below.

1. Interpretation of Subsurface Geology: Need to Resolve Inconsistencies (Section 2.3) - several inconsistencies in the interpretation of subsurface geology exist between Atlas geologic and geophysical studies. As a result, Atlas should be required to resolve these discrepancies in subsurface geology interpretations, and if necessary prepare a new subsurface geology model. These include, but are not limited to (UGS, Attachment 1):

   A. Location of the Moab Fault - and subsidiary faults, and a re-evaluation of the fault's dip beneath the tailings pile. The August, 1995 Cooksley Geophysical Report depicts the Moab Fault as near vertical, whereas nearby surface geologic mapping has shown the Main Moab Fault dips northeasterly (Doelling, et. al., 1995, Plate 2). This discrepancy confuses the location of where the Moab Fault system intercepts the base of the tailings pile.

   B. Resolution of the Apparent Absence of the West Branch of the Moab Fault - the August, 1995 Cooksley Geophysical study reported seismic reflectors to depths beyond 2,000 feet below the pile; yet failed to observe the northeasterly dipping West Branch of the Moab Fault mapped nearby by the UGS. The presence or absence of this fault below the pile has bearing on the potential for dissolution related subsidence and its effects on pile stability.

C. Location of a Buried Escarpment (Buried Scarp) - the January 29, 1996 Woodward-Clyde Report depicted the buried scarp at a location south of the tailings pile (ibid., Fig. 2-13). Contrary to this interpretation, previous Atlas studies have inferred the buried scarp to be located under the southern side slope of the tailings pile between piezometer B-2(14) and well ATP-2, see July, 1994 Canonie Environmental Report, Fig. 3, Cross-section B-B'. More important, however, this apparent truncation of bedrock formations and thick accumulation of Quaternary alluvium appears to be related to salt dissolution, see discussion below. As a result, the buried scarp under the pile may represent a vertical plane of potential preferential subsidence and has direct bearing on future pile stability. (3)

Future subsidence along the buried scarp could over-steepen the pile's southern side slope and may lead to slope failure, surface ponding of stormwater, or other adverse effects to embankment performance. Consequently, it is critical to constrain the strike and lateral extent of the buried scarp as it relates to the final design of the tailings pile. It is also important to determine the types of geological materials juxtaposed across this buried scarp in order to estimate both the total magnitude and rate of past subsidence in vicinity of the tailings pile.

It appears that additional boreholes are necessary to resolve these issues. We would recommend that such borings be completed to adequately constrain the stride of the buried scarp and the depth to bedrock/caprock. Said boring should be logged by qualified geologists, familiar with local stratigraphy. Other studies may also prove helpful, such as well planned seismic refraction studies, which could minimize the number of borings needed to constrain the buried scarp.

D. Thickening of Alluvium to the Southwest - the southwesterly thickening wedge of alluvium shown in the Aug. ·, 1995 Cooksley Geophysics Report (Line A, Fig. 1) contradicts nearby geologic mapping conducted by the Utah Geologic Survey (Doelling, et. al., 1995), and geologic borehole information provided by Atlas (July, 1994 Canonie Environmental Report). Other interpretations of the seismic data could easily explain the apparent southwest thickening trend in the alluvium (see Attachment 1). (4) PSJ

Confirmation of the southwest thickening is important to the evaluation of the style and magnitude of surface deformation that may result from subsidence. If thick alluvium is found north of the buried scarp, this may indicate enhanced dissolution of salt along the West Branch of the Moab Fault and/or subsidence induced movement of the fault.

E. Identification of Bedrock Formations and Depth to Caprock - seismic reflection studies conducted near the site have failed to recognize caprock beneath the pile and have estimated the depth to salt to be about 1,500 to 2,000 feet (January 9, 1996 Cooksley Geophysics, Addendum). This interpretation may be based in part (5) PS

on shallow boreholes on the west side of the pile which intercepted sandstone and shale interpreted to be Moenkopi and Chinle Formations. However, review of the geologic data from these logs shows insufficient information is available to conclusively justify these interpretations. As a result, it is unclear if the existing boreholes intercepted:

1) <u>Thick Sequences of Continuous Bedrock</u> - which would suggest the salt is at a greater depth. Such a subsurface model would suggest greater stability of the site in that it would be less prone to salt-dissolution induced land subsidence, or

2) <u>Bedrock Roof Pendants</u> - caught in the collapse of the nearby salt diapir. In this case, the bedrock beneath the site would be much less stable and prone to land subsidence due to the shallow occurrence of the Paradox Salt Formation. Salt dissolution collapse has created other areas of bedrock roof pendants in Moab Valley (Doelling, et. al., 1995, p. 48 and Fig. 6).

As a result, it appears that additional boreholes are needed across the site. The depth of such borings must be sufficient to distinguish between continuous bedrock formations which form country rock to the nearby salt diapir, and bedrock roof pendants overlying the diapir. As with all borings, detailed lithologic logs must be completed by qualified geologists familiar with local stratigraphy. Resolution of these two structural models for the site is critical to determination of any future rates of subsidence, and must be completed before any approval of the final engineering design.

F. <u>Need to Investigate Relationship of Buried Scarp and Saline Groundwater</u> - past Atlas studies have located saline groundwater at a depth of about 85 feet in wells ATP-1 and 2 (October 27, 1982 Dames & Moore Report, p. 7, and July, 1995 Canonie Environmental Report, Fig. 8). The occurrence of this brine in the vicinity of the buried scarp may not be coincidental, but represent active dissolution of the underlying Paradox Salt Formation. The brine's relatively shallow presence at a depth of 85 feet may also indicate the salt formation is found at a shallower depth than suggested by the Atlas seismic studies. If so, the stability of the tailings pile could be adversely impacted. For this reason, Atlas should determine the depth and subsurface locations of the alluvium/bedrock or caprock interface across the site. Such investigations should be closely coordinated with the State's hydrologic issues described below regarding horizontal extent of the freshwater/brine interface, see discussion below.

As a result of these apparent discrepancies and concerns, Atlas should be required to conduct further subsurface studies to adequately characterize local geologic conditions and provide information necessary to evaluate and resolve the stability of the pile with respect

(5) PSJ

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to salt-dissolution subsidence. Geologic boreholes should be installed deep enough to adequately determine and identify the bedrock formations found below the pile. In addition, Atlas should be required to resolve the inconsistencies found in the August, 1995 Cooksley Geophysics Report thru careful correlation of their seismic data with existing surface and subsurface geologic information. The tailings pile final engineering design and reclamation plan cannot be approved without prior resolution of these issues. **These are open State issues.**

2. Woodward-Clyde Structural Model B: Need for Re-evaluation and Single Model (Section 2.4.1.1 and 2) - review of structural model B provided in the January 29, 1996 Woodward-Clyde Report shows it largely unsupported by surface and subsurface geologic information now available. For example, cross-section C-C' of this report fails to acknowledge surface geologic mapping completed by the UGS (Doelling, et. al., August, 1995), and seismic information provided in the August, 1995 Cooksley Geophysics Report, both of which suggest that the Main Moab Fault should run thru the plane of the section. Furthermore, bedrock interpretations presented in this cross-section are unsubstantiated in that none of the wells depicted therein were drilled deep enough to intercept bedrock. In addition, Figure 2-13 of this same report fails to recognize the apparent strike of the buried scarp between piezometer B-2(14) and well ATP-2 near the central area of the pile's south side slope.

Consequently, Atlas should either abandon or otherwise discount structural model B as a subsurface model for the site, or be required to collect additional subsurface geologic information to justify it. Based on the site's geologic inconsistencies and discrepancies listed above, Atlas should be required to collect additional subsurface information. Final engineering design for the tailings pile must be based on a single, well documented subsurface geologic model for the site. NRC final approval of pile design or the reclamation plan should not be undertaken without prior resolution of this issue. **This is an open State issue.**

3. Subsidence: Shortcomings of Recent Atlas Studies (Section 2.4.1.3) - recently Atlas conducted soil trenching studies of alluvium at the mouth of Courthouse Wash. After review of January 29, 1996 Woodward-Clyde Report, wherein this study was documented, several open issues still remain regarding potential future land subsidence under the tailings pile, these are (Attachment 1):

A. Failure to Recognize and Investigate All Subsidence Mechanisms - we agree with the January 29, 1996 Woodward-Clyde Report that regional down-cutting by the Colorado River is a component needed to estimate land subsidence near the tailing site. Such down-cutting may be used to estimate age of terrace gravels near Courthouse Wash and infer a portion of local land subsidence experienced in the past. We also agree that bedrock knick-points found at the Portal and Matrimony Spring have and continue to control local river down-cutting. However, inherent in the January 29, 1996 Woodward-Clyde approach is the assumption that rates

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of local land subsidence and river down-cutting have been the same over geologic time. This assumption appears erroneous in that the presence of the Holocene-age marsh south of the tailings pile and the thick alluvial deposits found near the pile suggest that Moab Valley is subsiding at a rate greater than the river's down-cutting. Therefore, because local land subsidence has outpaced river down-cutting, Atlas must consider other mechanisms. 10 PS:

We also agree that the water level elevation of the Colorado River would form a local base level for tributary streams, such as Courthouse Wash. However, deposition of alluvial sands and gravels occurs below the river's water surface, and is therefore a separate mechanism that must be considered in addition to down-cutting by local tributaries.

Both the thick alluvium accumulations near the site (over 410 feet near well ATP-1) and the proximity of the Holocene-age marsh are most likely explained by the deposition or in-filling of sediment as the underlying salt is dissolved away by the river. This process is called aggradation, and is a significant component of land subsidence that Atlas should consider.

Unfortunately, the January 29, 1996 Woodward-Clyde Report failed to adequately investigate salt dissolution and aggradation in the matter of local land subsidence. As a result, Atlas should be required to investigate the age and rate of accumulation of these alluvial gravels in order to estimate past and future land subsidence near the tailings pile.

B. Lack of Age Constraints - age estimates for local alluvial deposits were extrapolated by the January 29, 1996 Woodward-Clyde Report from alluvium found at the south end of Spanish Valley, located many miles to the south. However, Atlas should be required to provide age dates of alluvial materials at the tailings pile site in order to determine local material age. If for some reason it is technically impracticable to gather this information, Atlas should be required to utilize a conservatively short age in derivation of local land subsidence rates. 11 PS

C. Determination of Local Maximum Alluvium Thickness - the rate of local land subsidence is based on the total or maximum thickness of alluvium at or near the tailings pile. Existing geologic borehole information where thick alluvium accumulations have been found, have failed to locate the top of bedrock, caprock, or salt formations which would in turn define the base and maximum thickness of local alluvial materials. Without this information, it is difficult to quantify the upper-bound or maximum rates of subsidence that should be used in evaluation of long-term slope stability and engineering containment integrity. 12 PS:

Unfortunately, the January, 1996 Woodward-Clyde Report relied on the August 1995 Cooksley Geophysics Report to estimate the total depth of local alluvial

materials. However, our review of the Cocksley seismic interpretations has shown poor correlation between it and the known surface and subsurface geologic data. Consequently, it appears that the base of the alluvial materials cannot be adequately known from the seismic data alone.

D. <u>Subsidence Investigation: Focus Needed on Buried Scarp</u> - review of the January 29, 1996 Woodward-Clyde Report shows no consideration given to rates of land subsidence as they relate to the buried scarp. Based on geologic data currently available, it appears that preferential subsidence is possible across this subsurface feature, and that said scarp underlies the southern side slope of the tailings pile. Furthermore, this scarp is located on the same side of the tailings pile as the Matheson Marsh, the apparent center of Holocene-age subsidence and deposition in Moab Valley. Consequently, Atlas should be required to investigate rates of subsidence as they relate to the buried scarp and to the area south of the scarp, and evaluate the potential for adverse impact therefrom on the final tailings pile design.

E. <u>Incomplete Settlement Analysis</u> - the January 29, 1996 Woodward-Clyde Report focused on shear strain analysis. However, this approach cannot adequately evaluate the type of surface disturbance that could impact the pile, i.e., preferential settlement, changes in slope, and/or surface deformation. This is particularly important in light of the buried scarp that appears under the southern side slope of the embankment. Consequently, Atlas should be required to conduct additional settlement analyses that can adequately evaluate these possibilities.

Consequently, Atlas should be required to install additional borings and/or conduct other studies across the site to determine the location of maximum alluvium thickness, relative to the tailings pile. In order to maximize efficiency and cost effectiveness of this exploration, we recommend that borings installed for this purpose be closely coordinated with other geologic and hydrologic investigations needed at the facility, see comments above and below. Without prior resolution of these issues, we believe it premature to approve any reclamation plan for the tailings facility. **This is an open State issue.**

3. <u>Landslide Hazards (Section 2.4.2.2)</u> - the Atlas evaluation of landslide hazards near the pile found in the December, 1995 Smith Environmental Technologies Report did not include evaluation of the potential for large-scale landslides from undercutting or toppling of a large rock slab from the cliff of Poison Spider Mesa (UGS, 1996, see Attachment 1 below). Atlas should be required to investigate this possibility and resolve all related engineering design implications. **This is an open State issue.**

<u>Comments on Geotechnical Stability (Section 3.0)</u> - preparation of these comments were closely coordinated with the Utah Geological Survey (UGS), whose original comments can be found in Attachment 1, below.

4. Water Quality Sampling During Piezocone Tests (Section 3.2.2.1) - we and other agencies have previously raised concerns regarding the lack of characterization of leachate water quality within the tailings pile. The penetrometer (cone penetration) tests requested by NRC would be an excellent opportunity to collect water quality samples of the tailings leachate, in that it is common for penetrometers to also be used for this purpose. We request, that the NRC ask Atlas to collect samples of the leachate at different depths within the tailings pile during these penetrometer tests and analyze them for all the parameters tested previously by the NRC. These parameters are outlined in an October 21, 1987 NRC letter and sampling report to Atlas.

5. Liquefaction Potential (Section 3.3.3) - Atlas has acknowledged the existence of liquefaction prone soils in both the tailings embankment and surrounding native soils Woodward-Clyde, 1996, p. 7-4). Atlas has further argued that these liquefiable soils are insignificant because they represent a small percentage of the total number of soil samples tested. However, if these few soil samples were to be clustered in one general location under the embankment, they could pose a local hazard to the final engineering design (UGS, 1996, and Attachment 1, below). For this reason, the NRC should require Atlas to disclose the horizontal and vertical location and distribution of the liquefaction-prone soil tests. Final approval of the engineering design of the tailings embankment cannot be resolved with this information and resolution of this issue. **This is an open State issue.**

6. Clay Radon Barrier Permeability (Section 3.3.4) - the NRC has not specified a maximum permeability for the clay radon barrier, nor required field testing during construction to confirm its as-built value. Consequently, NRC claims that the radon barrier will "... serve to prevent significant tailings recharge" remain un-quantified. The NRC should specify a maximum permeability for this clay and verify its as-built value by requiring permeability field testing as a part of a construction quality assurance/quality control program for the facility. **This is an open State issue.**

7. Radon Barrier Frost Penetration Calculations (Sections 3.3.4 and 6.2.3) - our review of the frost penetration calculations found in the March, 1995 Canonie Environmental Report, Appendix H has raised concerns in several areas, as follows:

   A. Source of Daily Temperature Records - the Berggren frost penetration model is dependent on daily average temperature values in order to predict total depth of frost penetration. Mention is made in the March, 1995 Canonie Environmental Report of 31 years of daily temperature records used in the frost prediction model for Atlas (ibid., p.1). However, our review shows approximately 106 years of climatic data is available for the town of Moab (Utah Climate Center, Utah State University, August, 1889 to September, 1995).

   Unfortunately, no information has been provided in either the Canonie report or the DTER regarding any NRC evaluation to determine if the 31 years used in the

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frost calculations are representative or conservative of the entire climatologic record available. Consequently, the NRC should complete a comparison of the temperature data used by Atlas with the total record available, so as to determine if the data used are representative or conservative of local historic conditions. Any approval of the final engineering design would be premature without this evaluation.

B. Moisture Content and Density - the Berggren frost depth prediction model is sensitive to moisture content, as well as other input factors (Aitken and Berg, 1968). Consequently, it is important to justify the moisture assumptions made for both the sandy soil above the clay radon barrier and the underlying clay. The Canonie report states that the moisture content and density variables used in the frost depth model were taken from geotechnical testing results provided in the 1992 Reclamation Plan (ibid p.2). It appears that these results came from uncompacted native soils in the vicinity of the facility, and not final engineered materials that will be constructed over the embankment.

It is also apparent that no compaction specifications have been required by NRC for either the sandy soil or clay radon barrier layers, hence the final field densities of these materials are uncertain. Although Atlas has stated they will derive their clay from a Mancos Shale outcrop north of the site, they have not identified a final borrow source for the clay, nor determined the moisture retention properties of either the native clay material or its compacted, engineered equivalent (DTER, p. 6-8). Without determination of these construction parameters, it is unclear how the frost modelling conducted could have been representative or conservative of final field conditions. Consequently, NRC should resolve these issues in order to adequately justify the final engineering design they will approve.

C. Long-Term Moisture Content of Cover Materials - to date Atlas has not conducted any moisture retention testing of the clay radon barrier borrow materials that will be used in the cover, nor have these tests been conducted on soil samples which meet required engineering specifications (DTER, p. 6-8). Nor has Atlas conducted any infiltration modeling to predict the long-term moisture content of the radon barrier cover materials after embankment construction. Consequently, it is uncertain if the one-time geotechnical test results provided in the Atlas 1992 Reclamation Plan, and used in the March, 1995 Canonie Environmental frost predictions are representative or conservative of the long-term moisture performance of the cover. Because the Berggren frost model is sensitive to moisture content, a conservative evaluation of frost depth penetration would include evaluation of frost penetration depth under simultaneous dry and cold conditions. The NRC should explain how the moisture content used in the frost penetration models was representative or conservative of long-term moisture conditions in the cover materials.

NRC should resolve these concerns and justify why Atlas's frost predictions, and their dependent data inputs are representative or conservative of the long-term field conditions that will exist in the cover materials. **These are open State issues.**

8. Desiccation of Clay Radon Barrier (Section 3.4.1) - the DTER outlines quality assurance criteria for which will allow as much as 48 hours pass before additional lifts are added to the clay radon barrier. This approach is a concern due to Utah's arid climate, which dictates careful moisture control of earthen materials during construction; particularly for swelling clays such as found in the Mancos Shale Formation. Such swelling clays are very prone to shrinkage cracking during drying. Our construction experience suggests that a 2-day interruption in clay lift placement, without prior field testing for moisture content, is too long and may result in shrinkage cracks and poor hydraulic and radon containment performance. This concern is heightened by the fact that the Atlas radon barrier design calls only for a thin layer of clay, only 8 to 12 inches thick, which will be more prone to desiccation cracking and less forgiving of construction flaws. 23 DSF

As consequence, NRC should require Atlas to either significantly increase the thickness of the clay radon barrier, or conduct daily field moisture and density measurements on every lift of the clay radon barrier. Such testing should be completed on working areas within a lift on a frequency of at least one test for every 100 foot by 100 foot grid. Areas of a lift which fail to meet the moisture specifications should be reworked until they meet the construction criteria. Each lift of the radon barrier should be visually inspected in the field for signs of desiccation cracking before placement of any new lift or overlying material. Areas observed with cracks in the clay radon barrier should also be reworked before placement of overlying materials. **This is an open State issue.**

Comments on Surface Water Hydrology and Erosion Protection (Section 4.0)

9. Discontinuity of Rock Wall (Section 4.5.1.2.2) - page 4-17 of the DTER describes how the rock wall across the northern toe of the tailings embankment will extend to the southeast and merge with the rock apron required to protect the pile from erosion by the Colorado River. However, review of the March, 1995 Canonie Report does not show any continuity between the rock wall and the rock apron (see Sheet 4/10, Drawing No. 88-067-E95). NRC should require revision of this engineering plan to reflect the design described in the DTER. **This is an open State issue.** 24 TL

10. Undisclosed Riprap Sources (Section 4.5.3) - our initial concerns for this section of the DTER focused on use of the igneous rock outcrop from Round Mountain in Castle Valley as a riprap source. However, recent correspondence from Atlas to Castle Valley residents has indicated another source of riprap has been located (March 8, 1996 Atlas letter from Richard Blubaugh). Despite this recent development, our concerns regarding this section are listed below in the event that Atlas returns to its original plans for Round Mountain. 25 TL

Review of the DTER shows that it does not identify all of the rock source locations considered for the riprap materials. Of particular interest is the source location of the rounded igneous rock, which has been reported to have sufficient rock quality to be used on the embankment, providing it was oversized. Discussion should be included in the DTER regarding the location of the rounded igneous rock source tested. The final EIS and TER must consider other factors in its evaluation of the final riprap sources, including transportation safety. This is of particular concern for the Round Mountain source, which will require special transportation considerations for State Highway 128.

Comments on Water Resources Protection (Section 5.0)

11. Need to Resolve Subsurface Geologic Model (Section 5.2.1) - Atlas subsurface geologic interpretations suggest that the Triassic Chinle and Moenkopi formations underlie the tailings embankment (Woodward-Clyde, November 3, 1995 Report, Figure 2-14). However, other bedrock units may also underlie the tailings embankment and mill site. Recent geologic mapping by the Utah Geologic Survey shows that Jurassic-age formations of the Glen Canyon Group (Navajo Sandstone, Kayenta Formation, and Wingate Sandstone) appear in nearby outcrop to the north and are found on the down-thrown hanging wall of the Main Moab Fault. Consequently, these Jurassic age formations may underlie the eastern portion of the tailings embankment and the mill site (Doelling, et. al., Plates 1 and 2). Contrasts in Atlas seismic reflection data across the Main Moab Fault may also support this interpretation (Cooksley Geophysics, August, 1995 Report, pp. 12-13, and Figures 1, 3, 4, and 6). In order to resolve this possibility and provide a sound subsurface geologic model, Atlas should be required to install additional borehole around the tailings pile and mill site. These studies should be closely coordinated with those needed to resolve other geologic inconsistencies, as listed above. Final approval of the reclamation plan cannot be completed without resolution of this issue. **This is an open State issue.**

12. Error in Conceptual Hydrogeologic Model for Site (Sections 5.2.3 and 5.2.4) - page 5-6 of the DTER equates bedrock units underneath the facility to the "lower groundwater system" of Blanchard (1990). This is a incorrect, in that Blanchard's "lower groundwater system" consists of Mississippian and older bedrock formations found stratigraphically below the Paradox Salt and thousands of feet beneath the Atlas facility (see Blanchard, 1990, p. 18). The bedrock formations found under the Atlas facility appear to be of Triassic and Jurassic age, and correspond to Blanchard's "upper groundwater system", in that they are found stratigraphically higher than the Paradox Salt (ibid.).

    This is an important distinction in the conceptual hydrogeologic model for the site in that one of the most prevalent and important aquifers found across the Colorado Plateau is the Jurassic-age Glen Canyon Group (Navajo Sandstone, Kayenta Formation, and Wingate Sandstone). Consequently, the DTER should be modified to reflect a more correct hydrogeologic model for the Atlas site. **This is an open State issue.**

13. <u>Permeability of Bedrock Units Near and Under the Site: Regional Data (Section 5.2.3)</u> - hydraulic properties for bedrock units under the Atlas facility should be measured in the field. If this is not technically practicable, they should be conservatively estimated. Review of regional hydrogeologic information suggests that the shaley Triassic-age Chinle and Moenkopi Formations form confining units in the Grand County area (Blanchard, 1990, p. 14); consequently they should be considered to exhibit low permeability. Shale formations commonly have very low permeabilities on the order of 1E-7 to 1E-11 cm/sec (Freeze and Cherry, p. 29). Although fracturing could increase their local permeability, one would expect such fractures to be healed or closed by swelling clays or by overburden pressures. Comparison of such low permeabilities with the average value reported for the alluvium (8.64E-4 cm/sec, DTER, p. 5-4) suggests that these Triassic-age formations could form no-flow boundaries for shallow groundwater flow.

As for Jurassic-age formations at the Atlas facility, the Navajo Sandstone, Kayenta Formation and Wingate Sandstone are much more permeable and form a regional aquifer that yields freshwater to seeps, springs, and wells in Grand County (Blanchard, 1990, p. 13). Regional hydraulic conductivity information suggests that the hydraulic conductivity for these formations can be rather high, particularly in fractured terrains, see summary in Table 1, below (USGS, 1988, Table 1):

Table 1. Regional Hydraulic Conductivity Summary: Glen Canyon Group

Geologic Formation	Type of Test	Reported Range of Hydraulic Conductivity		Notes
		ft/day	cm/sec	
Navajo Sandstone	core samples	0.002 to 6.12 (average = 1.53)	7.06E-7 to 2.16E-3 (average = 5.40E-4)	
	specific capacity	0.05 to 60	1.76E-5 to 2.12E-2	fracture enhanced
	aquifer tests	0.15 to 2.8	5.29E-5 to 9.88E-4	
	drill stem	0.009 to 18.5	3.17E-6 to 6.53E-3	fracture enhanced
Kayenta Formation	core samples	0.015 to 0.72	5.29E-6 to 2.54E-4	
Wingate Sandstone	core samples	0.31 to 1.11	1.09E-4 to 3.92E-4	

Highly fractured outcrops of these three formations are easily observed north of the Atlas facility. Consequently, the regional data from fractured terrains may be representative of

Glen Canyon Group could be as pe[illegible] [illegible]able than the average alluvium values presented by the [illegible] should be required to provide field testing to determine [illegible] heir site, or to use conservatively estimated hydraulic con[illegible] open State issue.

14. Permeability of Glen Canyon Group: Nearby USGS and NPS Pump Test Data (Section 5.2.3) - culinary use of groundwater from the Navajo Sandstone is currently made from wells at the Arches National Park Headquarters and Visitors Center, only about one-mile northwest of the Atlas facility. Public records from the Utah State Engineers Office document three wells have been completed in the Navajo Sandstone at Park Headquarters since 1940, see Attachment 2. below. The latter two wells, completed in 1958 and 1978, are still accessible at Park Headquarters. The 1978 well currently serves the public drinking water system at the Visitors Center and Park Headquarters (Blanchard, 1990, Table 8, and personal communication, Ms. Gail Menard, Park Acting Superintendent). Permeability data derived from pump and recovery test data for each of these wells is described below:

A. USGS Multiple Well Pump Test and Recovery Data (1958) - DRC staff review of the files of the Utah Division of Water Rights revealed a pump test was conducted during development of the 1958 replacement well by the U.S. Geologic Survey (USGS) for and in behalf of the National Park Service (Price, 1959, see Attachment 3, below). During second test, pumping was sustained for seven hours while drawdown measurements were made in the original 1940 well, located about 20 feet horizontally from the pumping well and completed at a comparable depth in the Navajo Sandstone. At the end of the second pump test, water level recovery measurements were also made in the 1958 pumping well.

DRC analysis of the drawdown data from the 1940 well (observation well), and recovery results from the 1958 well (pumping well) suggest the permeability of the Navajo Sandstone is between 3.14E-4 to 1.87E-2 cm/sec near Park Headquarters (see Attachment 4, pp. 2 and 3, below). Higher permeabilities may also be apparent, in that during the third and final pump test, conducted at the end of well development, a higher specific capacity was measured in the pumping well, compared to the two previous pump tests.

B. NPS Pump and Recovery Test Data (1978) - file research conducted by National Park Service staff also discovered well completion and pump and recovery test data for the 1978 water supply well at Arches National Park Headquarters (Bruce Rodgers, Canyonlands & Arches National Parks). This information, found in a September, 1978 report by U.S. Public Health Service (USPHS) staff attached to the National Park Service (NPS) is included herewith as Attachment 5 (A.V. Soukup, 1978).

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The September, 1978 USPHS/NPS report includes a well completion diagram and rudimentary geologic log. Little information is provided in the 1978 USPHS/NPS report regarding the authors of either the completion diagram or the geologic log. However, the 1978 geologic log should be considered suspect, in that DRC staff field and comparison of recent geologic mapping by the UGS (Doelling, et. al., August, 1995, Plate 1) has found the 1978 well had been drilled into an outcrop of Navajo Sandstone. Furthermore, the U.S. Geological Survey has determined that the 1978 well at Arches Headquarters is completed across the Navajo Sandstone [Blanchard, 1990, Table 8, well (D-25-21)21bdc-1]. As a result, the Navajo Sandstone identified in the 1978 log at a depth of 160 feet may be a minor lithologic change in the Navajo Sandstone, or could possibly the basal contact with the underlying Kayenta Formation. In any case, more credence should be given the well completion diagram than the geologic log in the USPHS/NPS report.

DRC staff analysis of pump test recovery data from the 1978 Well indicates the Glen Canyon Group has a permeability of 6.40E-2 cm/sec (see Attachment 4, p. 5). This is an even higher permeability than that measured in the pump and recovery tests completed in the 1940 and 1958 wells by the USGS. It is also interesting to note that all three wells at Park Headquarters are located on the down-thrown hanging wall of the Moab Fault (see Attachment 6, Figure 1). Furthermore, the 1978 well is located in closer proximity to the Atlas tailings pile and the extreme fracturing seen in Glen Canyon Group outcrops north of the Atlas site.

DRC staff recognize that the above pump test and recovery well data analyses are only estimates of actual field permeability in that the solution methods used are for classic darcian aquifer systems with primary granular permeability. Actual field conditions suggest that secondary fracture flow to the wells is a significant factor that must be considered in this analysis. The geologic log of the 1958 well reinforces this conclusion (Attachment 3, pp. 8 and 10-11), as does field observation of the fractured Glen Canyon Group outcrops. However, more sophisticated pump test solutions for dual porosity systems, or aquifers dominated by both granular and secondary fracture permeability, require additional input parameters in order to bound the permeability solution (Moench, 1984). These additional aquifer characteristics include fracture block thickness, fracture and formation storage coefficients; values which are not readily available. Consequently, these sophisticated analysis could not be completed without use of assumed input values; variables which at this time could not be justified. Consequently, DRC staff chose to use conventional pump test solutions, while recognizing that their results are likely only order of magnitude type of estimates of the true field permeability.

Notwithstanding, comparison of the USGS and NPS pump and recovery test results shows some very interesting information. First, the <u>lowest</u> permeability measured in the Navajo Sandstone at Park Headquarters, 3.14E-4 cm/sec (1958 well recovery data), is <u>higher</u> than

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the median alluvium permeability reported in the DTER ([illegible]E-4 cm/sec, p. 5-4). Second, the <u>highest</u> Navajo Sandstone permeability value found at Arches Headquarters, 1.87E-2 cm/sec (observation data from [illegible]40 well), is [illegible] times <u>greater</u> than the median permeability, and more than twice the permeability as the <u>highest</u> permeability reported for the alluvium at the tailings embankment (DTER, p. 5-4). Third, the highest Glen Canyon Group permeability measured at Arches Headquarters, 6.40E-2 cm/sec (recovery data from 1978 well), is 259 times <u>greater</u> than the median permeability, and 8 times <u>greater</u> than the maximum permeability reported by Atlas for the alluvium (DTER, p. 5-4).

As a result, the permeability of the Navajo Sandstone and other Glen Canyon Group formations near the Atlas facility may be on the order of 1.0E-2 cm/sec or greater. This value is considered representative for the following reasons:

A. <u>Multiple Test Results</u> - two separate pump tests from Arches Headquarters wells have indicated Glen Canyon Group permeability values on the order of 1.0E-2 cm/sec or greater. Such data included multiple well pump test completed in 1958, and single well recovery test from 1978 well.

B. <u>Greater Proximity of Atlas Site to Fractured Glen Canyon Group Outcrops</u> - the bedrock permeability values suggested by the USGS and NPS pump tests were derived from wells completed nearly a mile removed from the Moab salt diapir. Bedrock formations located in closer proximity to the Moab salt anticline have likely been subjected to greater faulting and subsidence in response to salt tectonics and dissolution. Consequently, outcrops and subcrops of the Navajo Sandstone or other Glen Canyon Group formations near and under the tailings pile will likely exhibit greater permeability than the pump test and well recovery results seen at Park Headquarters.

C. <u>Greater Density and Intersecting Sets of Joints and Faults</u> - surface geologic mapping completed by the Utah Geologic Survey indicates that a higher density of fracturing (joints and faults) occurs in the Glen Canyon Group outcrops southeast of Park Headquarters and immediately north of the Atlas facility (Doelling, et. al., Plate 1). These outcrops also exhibit two distinct sets of fractures: 1) a northwest striking set, and 2) an easterly to northeasterly trending set of joints and faults. This greater density and intersecting arrangement of fractures was likely caused by past salt tectonism and dissolution, and has likely resulted in terrain much more permeable than apparent near Park Headquarters.

Based on these observations, it appears that the permeability of the Navajo Sandstone and/or Glen Canyon Group formations near the Atlas facility is likely on the order of 1.0E-2 cm/sec or greater. It is also important to note that this permeability corresponds with regional values for fractured regimes in the Glen Canyon Group, see Table 1 above.

These permeability conclusions suggested by nearby pump tests contradict assumptions made previously by Atlas that all bedrock under and adjacent to the facility was impermeable. Based on this earlier assumption, Atlas claimed that the shallow alluvial aquifer underlying the site is hydraulically isolated from the underlying bedrock formations (Western Technologies, March, 1989, p. 5). However, our findings now suggest that the Glen Canyon Group formations near the Atlas facility are <u>more</u> permeable than the shallow alluvium. This in turn suggests a high likelihood of hydraulic connection between the shallow alluvial aquifer beneath the tailings pile and millsite facilities, and the underlying Glen Canyon Group formations. 29 MCL

The NRC must revise their interpretation in the DTER regarding the permeability of bedrock units beneath and adjacent to the Atlas facility to reflect both quantitative and qualitative tests and measurements made and reported by other federal and State government agencies. Atlas should also be required to investigate the possibility of hydraulic interconnection between bedrock formations and the shallow alluvium. These are open State issues.

15. <u>Need to Characterize Extent of Fresh/Saline Groundwater Flow System Interface (Section 5.2.4)</u> - we agree that deep saline groundwater found below Atlas may form a basal no-flow boundary to the uppermost aquifer. Such a freshwater/brine interface could constitute a basal no-flow boundary for the shallow aquifer, below which contaminants from the tailings pile could not travel. However, such a freshwater/brine interface is not a fixed, physical boundary, but a transient hydraulic barrier that will rise and fall in response to changes in head in either of the flow systems. A similar conclusion has been reached previously by Atlas (Western Technologies, March, 1989 Report, p. 6). 30 MCL

Unfortunately, NRC files show that Atlas has only confirmed the presence of this deep brine system at two points at the facility in wells ATP-1 and 2 at the southeastern margin of the tailings pile (Dames & Moore October 27, 1982 Report, p. 7). In well ATP-1 Atlas found the brine interface at an elevation of approximately 3,880 feet (ibid.). In well ATP-2 it was found about 8 feet lower at an elevation of 3,872 feet (ibid.), suggesting the deep brine flows towards the Colorado River. This is consistent with regional groundwater studies which suggest groundwater in the Glen Canyon Group and younger formations also flows toward the river (Blanchard, Fig. 9). Consequently, it appears that the deep brine found near the site may be simply a density stratification phenomenon of the same general groundwater flow system, with fresh groundwater in the Glen Canyon Group becoming saline after encounter with the Paradox Salt Formation at depth. Atlas should be required to investigate this possibility in development of a sound hydrogeologic model for the facility. Such studies should be carefully coordinated with other investigations needed for geologic model purposes, see discussion above.

If this conceptual model is correct, it would suggest that the fresh groundwater/brine interface is limited in its horizontal extent, i.e., found only in close proximity to subcrop of the Paradox Salt Formation. If this is the case, the source of the deeper saline water

could simply be explained by deeper groundwater flow paths contacting and dissolving the Paradox Salt. Such a case could explain the presence of the buried scarp found in subcrop south of the tailings pile, and have significant implications on rates of land subsidence, an NRC open issue identified in Section 2.4.1.2 of the DTER, and discussed above.

As a result, the NRC should require Atlas to make efforts to develop a justifiable and sound hydrogeologic model for the facility. This include determination of the lateral extent of the freshwater/brine interface across the facility. These efforts should include the drilling of deeper groundwater monitoring wells and groundwater resistivity logs at the facility. Nested monitoring wells that allow ongoing monitoring of groundwater quality may also be needed. **This is an open State issue.**

16. <u>Confusion of Regional Bedrock Groundwater Flow Directions (Section 5.2.4)</u> - review of the DTER shows confusion exists about regional groundwater flow directions in bedrock near the Atlas site (DTER, p. 5-9). As discussed above, bedrock units of hydrogeologic interest are those Triassic and Jurassic-age formations found in the immediate vicinity of the site However, the DTER suggests that bedrock units on the Atlas site are equivalent to Blanchard's "lower groundwater system", and that groundwater therein flows to the southwest. This NRC correlation is flawed, in that Blanchard's "lower groundwater system" are those Mississippian-age and older formations found 1,000's of feet below the Atlas site and hydraulically isolated by the Paradox Salt Formation (Blanchard, 1990, p. 18).

The correct interpretation would be to correlate the Triassic and Jurassic-age bedrock formations near the Atlas facility to the "upper groundwater system" of Blanchard (ibid.). Accordingly, groundwater in the Glen Canyon Group in the "upper groundwater system" flows to the southeast and discharges to the Colorado River (Blanchard, 1990, Figure 16). **This is an open State issue.**

17. <u>Hydraulic Connection of Bedrock and Shallow Alluvium (Section 5.2.4)</u> - we agree that groundwater in the Glen Canyon Group on Poison Spider Mesa west of the Atlas facility is not hydraulically connected to the shallow alluvium under the tailings embankment thanks to the underlying position of the thick, shaley Chinle and Moenkopi Formation aquitards in the mesa's escarpment. However, we cannot agree with NRC statements that the shallow alluvium is hydraulically isolated from <u>all</u> bedrock formations at the Atlas facility (DTER, p. 5-9). Such a conclusion contradicts the following findings:

A. High permeability found in the USGS pump tests of the Glen Canyon Group in Arches National Park,

B. The Glen Canyon Group's highly fractured nature in outcrop immediately north of Atlas millsite, and

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C. USGS finding of regional discharge of the Glen Canyon Group aquifer to the Colorado River.

Furthermore, a hydrogeologic cross-section prepared by DRC staff shows that hydraulic head in the 1978 Well at Arches National Park had a higher head than the Colorado River (see Attachment 6, Figure 2). Hence, groundwater in the shallow bedrock in Arches National Park discharges to the Colorado River. This conceptual model agrees with regional USGS interpretations (Blanchard, Figure 9) and mandates hydraulic connection between the shallow bedrock alluvium units.

As seen in the DRC hydrogeologic cross-section, the initial water level found in the 1978 Arches National Park Headquarters well, completed in the Navajo Sandstone, indicate a static water table elevation of 3,966 feet amsl at a distance of about one mile northwest of the Atlas facility (4,080 ft - 114 ft, Blanchard, 1990, Table 8). This is about 14.4 feet higher than the river's elevation in April, 1994 (3,951.6 feet amsl, Smith Environmental Technology Corporation Report, Fig. 1), and 7.8 feet higher than the static water level reported in shallow alluvial monitoring well ATP-3 found about 500 feet north of the tailings embankment (3,957.6 ft amsl, ibid.). Previous Atlas studies have also concluded that groundwater in both bedrock and alluvium near the Atlas site discharges to the Colorado River (EnecoTech February 25, 1988 Report, p. 17).

In light of this evidence, the NRC should revise its statements in the DTER and acknowledge discharge of the shallow bedrock aquifer to the Colorado River, and hydraulic connection between said aquifer and the shallow alluvium under the Atlas tailings embankment and millsite. **This is an open State issue.**

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18. <u>Need for Additional Monitoring Wells Near Southern Property Boundary (Section 5.2.4)</u> - we agree with the NRC Open Issue 15, in that Atlas had not justified the groundwater flow directions depicted south of the tailings pile in the July, 1994 Canonie Environmental Report (Fig. 4). We have also reviewed the recent Atlas response to NRC Open Issue 15 (February, 1996 Smith Environmental Technologies Corporation). From review of the February, 1996 water table contour map (ibid., Fig. 1) it appears Atlas has made improvement in acknowledging the lack of groundwater recharge and hydraulic head from Poison Spider Mesa, west of the tailings pile. However, at this time several important issues must be considered and resolved:

A. <u>Triangulation Limitations of Existing Well Configuration</u> - the existing monitoring well network south of the tailings pile appears to be aligned approximately along a single equipotential line (Atlas wells AMM-3, MW-1-R, ATP-2-S, MW-2-R, and MW-3). This configuration lends itself well to triangulation with piezometers near the top of the pile to the north to determine leachate flow directions across the pile's side slope area. However, it provides very little benefit for determining groundwater flow directions between the toe of the pile and the Colorado River. Consequently, Atlas should be required to install additional monitoring wells south

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and east of the monitoring wells in question in order to triangulate groundwater heads and determine flow directions outward from the toe of the pile.

We would recommend installation of at least three new monitoring wells along the southeastern access road found between the mouth of Moab Wash and the southern property boundary. These wells should be installed in the uppermost aquifer at locations that are interspersed approximately midway between the existing wells near the toe of the tailings pile (MW-1-R, ATP-2-S, MW-2-R, and MW-3. (33)

B. <u>Need for Additional Offsite Monitoring Wells</u> - high uranium and other contaminant concentrations have been detected in Atlas well AMM-3, completed near the southern-most end of the tailings pile (July, 1994 Canonie Environmental Report, Figs. 5-7). Based on the apparent southerly component of groundwater flow, Atlas should be required to install at least two more additional monitoring wells near their southern property boundary, south of well AMM-3. Without installation of these wells Atlas will not be able to demonstrate isolation of their contaminants from adjoining private property and groundwater sources (10 CFR 40, Appendix A, Criterion 1). (34) MC

After installation of these new monitoring wells, Atlas should be required to sample them for both water level and collect water quality data. Thereafter, head data should be reported both in tabular and water table contour map formats. All water quality data should be reported in both tabular and graphical formats.

After completion of the new monitoring wells mentioned above, the NRC should evaluate groundwater flow directions and water quality near the southern-most Atlas property boundary. If at this time either the NRC or the State determine that tailings contaminants have been released from the facility and now underlie private property, or if said release is found imminent, Atlas should be required to install additional monitoring wells on the private property to define the horizontal and vertical extent of the contamination.

C. <u>Need for Continued River Level Monitoring</u> - in conjunction with the additional monitoring wells required, Atlas should be required to establish stations along the river bank where river stage or water level measurements can be made. River head measurements thereby made should be reported in conjunction with other groundwater head data. (35) MC

D. <u>New and Existing Well Construction Considerations</u> - all new monitoring wells must conform with the U.S. Environmental Protection Agency "RCRA Ground-Water Technical Enforcement Guidance (TEGD) Document (1986). Well screen and filter pack intervals should be kept to a minimum, so as to avoid borehole dilution caused by long intervals. Well screen placement should be governed by (36) M

the soil/aquifer permeability encountered, with emphasis placed on high permeability intervals. Well construction should be based on detailed geologic logs of earthen materials, and supported with all necessary laboratory and field testing.

After completion of the new mo...oring wells and compilation of their well construction details and geologic logs, the former monitoring wells should be evaluated to determine if they meet current EPA standards (RCRA TEGD), see discussion below. If for any reason they do not, Atlas should be required to replace these wells accordingly.

36 MCL

Under 10 CFR 40, Appendix A, Criterion 1, Atlas is required to demonstrate that the reclamation design will "... contribute to immobilization and isolation of contaminants from ground-water sources". No distinction here is made in Criterion 1 between existing and future sources of groundwater. Consequently, Atlas should be required to demonstrate isolation of its contaminants from future potential sources of groundwater, particularly those that exist on adjoining public or private property.

37 MHF

Atlas's disclosure of release of high concentrations of tailings contaminants near the toe of the facility, combined with the State's determination that similar contaminant levels have been found in seeps along the bank of the Colorado River (see discussion below) strongly suggest that Atlas be required to track down the horizontal and vertical extent of their contaminant plume, even if it means drilling wells on property it does not own. It is clear that Atlas cannot satisfy Criterion 1, nor can the Reclamation Plan approved without prior resolution of these issues. **These are open State issues.**

19. <u>Potential for Off-Site Groundwater Contamination Under Arches National Park (Section 5.2.5)</u> - because tailings related contaminants have already been found in the shallow aquifer below the tailings pile, it is clear that leachate within the tailings pile is in intimate hydraulic connection with uppermost aquifer. As a result, head in the tailings pile is integrally related to head the shallow aquifer, and head comparisons should be made between the maximum heads in the embankment and other locations.

38 MCL

Hydraulic head in the tailings pile has been significantly higher than nearby heads in the uppermost aquifer. Atlas information shows that the water surface elevation of the pond on top of the tailings pile has been as high at 4,047.1 feet above mean sea level (ft amsl, see Western Technologies March, 198? Report, Figure 3.4). Recent pond elevation data indicates it had declined by about 18 feet (4,029 ft amsl, April, 1994, Canonie Environmental July, 1994 Report, Table 3 and Appendix B, Graph B-5). No piezometer data has been made available to use to document the current potentiometric level within the tailings, particularly near the center of the tailings pile. Consequently, the current maximum head in the pile is unknown.

Water level data collected during installation of the 1978 Arches National Park drinking water supply well shows the uppermost bedrock aquifer at that location had a hydraulic head of 3,966 ft amsl (Blanchard, 1990, Table 8). This is about 81 feet lower than the 1989 tailings pond elevation and 63 feet lower than the 1994 pond elevation. As a result, there is a potential that hydraulic head from the tailings pile could have caused a local reversal of hydraulic gradient, forcing leachate contaminants to travel in a northerly direction, see DRC hydrogeologic cross-section in Attachment 6 (Figure 2).

Available hydrogeologic data found during our review contradicts previous Atlas statements. In 1982, Atlas claimed that groundwater pumping at Arches Headquarters could not induce ground water flow from the tailings site because "... the bottom of the Arches well is about 10 feet above the elevation of the water table at the Atlas site..." (Dames and Moore October 27, 1982 Report, p. 12). However, our review shows this statement is in error in that the bottom of the 1978 Park Headquarters well is about 50 feet lower than the lowest water table elevation at the facility (compare Blanchard, Table 8 and Atlas well ATP-1-S in Canonie Environmental July, 1994 Report, Figure 4). Furthermore, the base of the 1978 Park Headquarters well is below the Colorado River's reported water level (see Attachment 6, Figure 2).

As a result, there exists a possibility that head in the tailings pile could have driven leachate contaminants northward across the boundary of Arches National Park. To date, Atlas has not been required to investigate this possibility.

This possibility is supported by several lines of evidence, including:

A. Long Tailings Existence - the Atlas tailings pile has existed since 1956, resulting in 40 years for the leachate mound in the pile to alter local groundwater flow directions. Radial flow away from the leachate mound could have taken contaminant in many directions, including northerly toward Arches National Park.

B. Lack of Groundwater Water Quality Data - to confirm water quality conditions in the shallow aquifer north of the tailings pile. Although head monitoring may continue in small handful of alluvial monitoring wells installed north of the pile, our review of the Atlas docket file at the NRC shows Atlas has performed little if any groundwater quality monitoring north of the tailings pile since abandonment of well ATP-3 as a "background" monitoring point in 1988. Consequently, there has been a long history wherein Atlas was not required to monitor water quality to the north of the tailings pile for this possibility.

C. Sparsity of Groundwater Head Data: Unjustified Flow Directions - Atlas reports shows that five alluvial monitoring wells are currently found north of the tailings pile, ATP-3, TH-26, TH-21, TH-22, and TH-25 (compare February, 1996 Smith Environmental Technologies Corporation Report, Fig. 1 with July, 1994 Canonie

Report, Table 1). None of these wells are found at the northern Atlas property boundary.

Atlas has reported that a hydraulic barrier exists in the form of a trough in the groundwater table along the strike of Moab Wash, isolating the tailings pile from Arches National Park (Dames & Moore October 27, 1982, Figures 2 and 3; Canonie Environmental, July, 1994, Figure 4, February, 1996 Smith Environmental Technology Corporation, Figure 1). However, this interpretation is unjustified in that additional water level data would be required north of Atlas wells ATP-3 and TH-25 to support this conclusion. Consequently, Atlas should be required to install additional monitoring wells along their northern property boundary and/or inside the Arches National Park boundary to confirm this conclusion.

Another equally valid interpretation of groundwater flow north of the tailings pile is also apparent. Triangulation of water levels collected in April and May, 1994 in Atlas wells ATP-3, TH-26, TH-21, and TH-25 suggests northerly flow toward Arches National Park (see head data found in February, 1996 Smith Environmental Technologies Report, Figure 1). This interpretation would place the easterly flowing groundwater trough at a location farther north, thus allowing leachate contaminants from the tailings pile to invade Arches National Park.

To add to this problem, little historic water level data is available from the 1978 Arches National Park Headquarters well. For this reason, Atlas should be required to characterize hydrogeologic conditions near its northern property boundary through installation of additional monitoring wells and piezometers. If tailings contaminants are found at the northern Atlas property boundary, Atlas should be required to install additional monitoring wells inside Arches National Park to define and characterize the horizontal extent of their contamination. Head measurements at these locations should then continue for the foreseeable future in order to establish and monitor groundwater conditions in this area, and document the control of leachate contaminants.

E. <u>Lack of Bedrock Permeability Characterization</u> - previous Atlas hydrogeologic studies have assumed that all bedrock formations under the facility are impermeable and form no-flow boundaries (Western Technologies March, 1989 Report, p. 5). However, Atlas has never been required to confirm this critical assumption. DRC analysis suggests that the Glen Canyon Group is very permeable, see discussion above. As a result, leachate from the tailings could have flowed through the underlying alluvium, entered permeable underlying bedrock formations and been driven northward and encroached upon National Park Service property.

38

MCL

F. Apparent Uranium Concentration Increase in Well ATP-3 - despite the data quality assurance concerns raised below, uranium concentration data from well ATP-3 suggest increasing uranium concentrations may have been present in this well thru the second quarter of 1983 (see Attachment 8, Chart 1). Such increases should have raised concerns on the part of NRC to investigate the possibility of northward flow of leachate contaminants toward Arches National Park and establish additional compliance monitoring wells between the tailings pile and the National Park. Instead, the NRC approved discontinuance of groundwater quality monitoring in well ATP-3 in 1988 (DTER, p. 5-10). It is also interesting to note that after shutdown of the mill in 1984, that the uranium concentrations Atlas found in well ATP-3 fell and stabilized. Atlas should have been required to explain this coincidence before removal of well ATP-3 as a "background" groundwater monitoring point.

38 MC

Once again, Criterion 1 of 10 CFR 40, Appendix A requires that uranium tailings sites be evaluated to determine if hydrologic and site conditions will "... contribute to immobilization and isolation of contaminants from ground-water sources". Accordingly, future withdrawal of groundwater from the shallow bedrock system north of the tailings pile must be protected. The public drinking water supply well at Arches National Park Headquarters is completed in this shallow groundwater system.

Based on our review of the NRC file materials and Atlas reports, we have concluded:

1. Significant evidence exists which suggests that historic operation of the Atlas tailings pile may have contaminated groundwater beneath Arches National Park,

2. To date, Atlas has not been required to evaluate or characterize the presence, concentrations, and lateral extent of tailings contaminants in the shallow aquifer north of the tailings embankment, and

3. Such potential may have already adversely impacted groundwater quality, and may thereby limit future uses of groundwater in the shallow bedrock aquifer north of the tailings pile.

Consequently, it appears that Atlas has not satisfied Criterion 1. Accordingly, NRC should require Atlas to demonstrate that contaminants from both the tailings pile and the former mill site will not pose an adverse impact on the groundwater supply both north and south of the tailings pile. This demonstration should include characterization of hydrogeologic conditions, local groundwater levels, and lateral extent of groundwater contaminants north of the tailings pile. Such characterization can only be completed after installation of additional monitoring wells north of the pile and collection of pertinent hydrogeologic and groundwater quality data. **This is an open State issue.**

20. Lack of Characterization of Hydrogeologic Conditions under Former Mill Site (Section 5.2.5) - review of NRC docket files has shown that historically little if any characterization of hydrogeologic conditions under the mill site has been required of Atlas. In fact after review of all the Atlas hydrogeologic reports found in the NRC docket files, only one monitoring well could be located in the mill site proper (see "Boneyard" well in March, 1989 Western Technologies Report, Figure 3.4). Consequently, little is known regarding hydrogeologic conditions around the mill site and east of the tailings pile. 39 MCL

This lack of hydrogeologic information combined with the type and age of the Atlas facility causes concern regarding the potential for 40 years of historic operations to have polluted groundwater quality. Such historic facilities that raise concern include, but are not limited to: unlined ore storage areas, unlined wastewater and raffinate treatment ponds, and unlined stormwater catchment basins that may have received inadvertent spills of hazardous materials. As a result, Atlas should be required to characterize hydrogeologic and groundwater quality conditions under the former mill site.

The former mill site is located east and downgradient of the tailings pile (February, 1996 Smith Environmental Technologies Report, Figure 1). Consequently, hydrogeologic characterization of the mill site area is an important part of defining the lateral extent and concentrations of tailings contaminants that can be released to the environment. In light of the known release of tailings contaminants to shallow groundwater near the southern and southeastern margins of the tailings pile, it is reasonable to expect similar contaminant releases under the mill site area east of the pile.

Furthermore, 10 CFR 40, Appendix A, Criterion 6(7) requires Atlas to:

> "... address the non-radiologic hazards associated with the wastes in planning and implementing closure. The licensee shall ensure that disposal areas are closed in a manner that minimizes the need for further maintenance. To the extent necessary to prevent threats to human health and the environment, the licensee shall control, minimize, or eliminate post-closure escape of non-radiologic hazardous constituents, leachate, contaminated rainwater, or waste decomposition products to the ground or surface waters or to the atmosphere."

It is clear that without hydrogeologic characterization of the mill site and determination of the lateral extent and concentration of tailings contaminants in this area, Atlas will not be able determine the necessary measures to control non-radiologic contaminants from the tailings pile. Consequently, without prior resolution of this issue Criterion 6(7) cannot be satisfied, nor the Reclamation Plan approved. **This is an open State issue.**

20. Lack of Quality Assurance/Quality Control in Historical Atlas Groundwater Quality Data (Section 5.2.5) - the DTER explains in 1988, after 32 years of facility operation, the NRC approved relocation of the background groundwater monitoring point from an area north of the tailings pile (Atlas well ATP-3) to the northeast corner of the mill site area (Atlas well AMM-1, DTER, p. 5-10). During research into the NRC docket files to determine the justification for this change, we discovered a number of quality assurance issues in the ATP-3 data, that if indicative of historic groundwater monitoring conditions, may shed doubt on all historic groundwater quality data collected by Atlas.

(40) MCL

In interest of time, we focused on uranium as a key contaminant due to its abundance in the tailings material and its known occurrence as a shallow groundwater contaminant south of the tailings pile (Canonie Environmental July, 1994 Report, Figure 5). This review of NRC files found 31 Atlas uranium samples collected from well ATP-3 between June 15, 1982 and November 4, 1988. Most if not all of this data had significant quality assurance problems, including (see summary of Atlas data in Attachment 8, below):

A. Lack of Reporting of Error Terms and Lower Limits of Detection (LLDs) - 20 samples were found lacking these values with the reported groundwater results (see Attachment 8, below). Consequently, the reviewer cannot determine if the reported result is above the LLD, or if the measurement had sufficient counting precision to be reliable.

B. Excessive Error Terms - reported in great excess of the reported concentrations (4 samples: 6/15/82, 7/28/82, 8/30/82, and 9/21/82). In all four cases identified, the associated error term was many orders of magnitude greater than the reported value.

C. Excessively High LLD Values - that exceeded applicable groundwater quality standards (1 sample, dated 9/20/84). As a result, the reviewer could not determine if the reported value was above or below the applicable groundwater quality standard.

D. Failure to Investigate Erratic Results - review of Atlas uranium results from well ATP-3, expressed in units of pCi/l, shows highly erratic laboratory results. In one case, two samples collected from well ATP-3 within seven (7) days of each other; however, Atlas reported results that were different by a factor of 247% (21 vs 8.5 pCi/l, 11/30/82 and 12/7/82, respectively). Based on groundwater flow velocities expected in the vicinity of well ATP-3, there appears to be no physical field cause for this difference. Unfortunately, both NRC and Atlas failed to recognize this large discrepancy and investigate its cause. It is also interesting to note how the erratic nature of the data diminished after closure of the mill in 1984, see Attachment 8, Chart 1.

E. Questions Regarding Adequacy of Well Completion - it appears that well ATP-3 was abandoned as a "background" monitoring well, in part, after Atlas raised concerns when it went dry during certain periods of the year (DTER, p. 5-10). However, this suggests that the well was not completed deep enough to accommodate the seasonal variation in the water table at that location; suggesting that a deeper replacement well should have been installed instead. Such an approach appears appropriate today given the current understanding of hydrogeologic conditions at the site. However, thanks to the NRC approval we have no water quality data available after 1988 in the area north of the tailings pile. This constitutes a serious void in the monitoring program for the tailings site.

F. Lack of a Groundwater Sampling Quality Assurance/Quality Control Plan - DRC review of the NRC docket file failed to locate any quality assurance plan for the facility to ensure adequate sampling/analytical methods and data integrity. As a result, significant doubts exist regarding adequate monitoring well construction and materials, well sampling equipment and methods, sample control and preservation, etc.

G. Lack of Identification of Analytical Methods - used for all the results reported. Consequently, it is uncertain if these tests were conducted in accordance with certified or standardized analytical methods.

H. Lack of Analysis by an Independent Certified Laboratory. review of the NRC docket files shows that all analyses were completed by an in-house Atlas laboratory. No records were found to demonstrate that the Atlas laboratory had at any time been certified by any federal or State government agency. Nor did the monitoring records indicate if independent analytical services were ever used to analyze the samples reported.

40 MCL

As a consequence of these quality assurance flaws and concerns, DRC staff concluded that historic Atlas uranium groundwater quality data from well ATP-3 is inconclusive. If these same conditions exist in the historical Atlas groundwater quality database for other radiologic and non-radiologic contaminants, then similar doubt also exists for other wells and parameters. Consequently, the NRC should:

1. Conduct a detailed and thorough quality assurance evaluation of all historic Atlas groundwater quality monitoring techniques and data to determine its reliability, including, but not limited to evaluation of:

    - Monitoring well construction and construction materials,

    - Monitoring well sampling equipment and field methodology,

- Use of standardized or certified analytical methods for both radiologic and non-radiologic contaminants.

- Use of certified analytical laboratories.

2. Require Atlas to submit and implement a detailed groundwater sampling quality assurance/quality control plan which complies with all requirements of the EPA RCRA TEGD (1986).

After completion of this review, monitoring wells, piezometers, and/or groundwater quality data found not to meet these criteria should be removed from consideration, and Atlas required to replace them as necessary. See discussion below regarding groundwater corrective action monitoring plan. **This is an open State issue.**

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21. Suspect "Background" Conditions in Well AMM-1 (Section 5.2.5) - we agree with NRC Open Issue No. 16 that Atlas well AMM-1 may be located in an area previously impacted by facility operations, and hence may not represent background conditions. This is based on the following facts:

41 MCL

A. Proximity of Well AMM-1 - to the former ore storage pad. In fact, the well is located only about 400 feet northeast of the storage pad.

B. Open-Air Storage - the former storage pad was of an open-air type construction where the ore was subjected to precipitation, which in turn could leach contaminants and carry them to the underlying water table.

C. Late Installation - well AMM-1 was not installed until September, 1988, about 32 years after facility went into operation (Western Technologies, October 31, 1988 Report, p. 6). Consequently, the water quality encountered upon installation of the well could have already been impacted by historical operation of the facility, see discussion below.

Review of the recent Atlas response to NRC Open Issue No. 16 shows that all of these facts were ignored in their evaluation (February, 1996 Smith Environmental Technologies Report). Consequently, additional discussion follows.

Review of the former mill site facilities f om previous Atlas reports shows prior to installation of well AMM-1, Atlas operated at least one water clarification lagoon for the mill's water supply system, located approximately 800 feet southwest of the ore storage pad in question. This lagoon had a water surface elevation of 3,972.5 ft amsl (Dames & Moore October 27, 1982 Report, Figure 1 and Western Technologies March, 1989 Report, Figure 3.4). Based on our understanding of the facility, it is assumed that this water clarification lagoon existed since initial operation of the mill. Unfortunately, no information has been made available on the type of liner that may have existed under it.

However, based on era in which the lagoon was constructed, little of any liner is expected to have been installed beneath it. Furthermore, no information has been provided regarding its historical maintenance. Consequently, it is reasonable to assume that little if any liner existed in the water clarification lagoon during operation of the facility.

41 MCL

Because the lagoon provided intake water for the Atlas mill, it is reasonable to expect near-constant head conditions in it. Any leakage from the lagoon could provide a constant source of artificial recharge to the shallow aquifer and could have easily altered local groundwater flow directions, causing a groundwater mound to form under the lagoon and radial flow away from it. The location of this lagoon is important because it is located southwest of both well AMM-1 and the ore stockpile in question. Consequently, groundwater could have been forced to flow in a northeasterly direction under the ore stockpile and towards the location where well AMM-1 was eventually installed.

Review of head data from the only well reported completed in the mill site further reinforces this possibility, in that the "boneyard" well shows a head that is about 0.27 feet higher than well AMM-1 (Western Technologies March, 1989 Report, Figure 3.4). This is important because the "boneyard" well is located closer to the Colorado River than well AMM-1, at a distance of about 750 feet versus about 820 feet, respectively. Consequently, the "boneyard" well should show a lower head than AMM-1.

Further evidence is apparent after comparison of Atlas water level information which suggests that head in the clarification lagoon was about 20 feet higher than the average head reported in well AMM-1 (ibid., compare lagoon water surface elevation, with well AMM-1 hydrograph in Canonie Environmental July, 1994 Report, Appendix B, Graph B-1).

Consequently, such northeasterly flow in the shallow aquifer from the lagoons toward the vicinity of well AMM-1 could have easily carried ore stockpile contaminants. It is also important to note that head reported in the "boneyard" well (3954.53 ft amsl) was midway between the head reported in the clarification pond (3972.5 ft amsl) and that found in well AMM-1 (3954.26 ft amsl) in December, 1988 (Western Technologies March, 1989 Report, Figure 3.4).

It is also important to note that if recycling of tailings pond effluent was ever conducted at the facility, that the possibility of impounding such recycled wastewaters in the clarification lagoon would have also created a source of groundwater contamination apart from the ore stockpile areas in the mill site.

In order to assess if the 32 years of mill operation was sufficient to cause groundwater pollution in the vicinity of well AMM-1, prior to its installation, the staff undertook an estimate of advective groundwater contaminant velocity (v) in the shallow aquifer, as follows (Domenico and Schwartz, p. 360):

$$v = \frac{K * dh/dl}{n_e}$$, where:

- K = average alluvium permeability = 2.4 ft/day (DTER, p. 5-4)
- dh/dl = apparent hydraulic gradient between clarification pond and well AMM-1. = (3972.5 - 3954 ft) / 1,700 ft = 0.0109
- n_e = effective porosity of alluvium, assumed to be 0.30.

$$= \frac{2.4 \text{ ft/day} * 0.0109}{0.30}$$

$$= 0.0871 \text{ ft/day}$$

Based on this velocity, the time needed for advective contaminant transport from the ore stockpile to the vicinity of well AMM-1 can be estimated as follows:

$$t = \frac{d}{v}$$, where:

- t = advective contaminant travel time
- d = distance traveled between ore stockpile and vicinity of well AMM-1.

$$= \frac{400 \text{ feet}}{0.0871 \text{ ft/day}} = 4.595 \text{ days} * \frac{1 \text{ yr}}{365.25 \text{ days}} = 12.57 \text{ years}$$

Because this contaminant travel time is based on the advective velocity calculations, it represents the time needed for the 50% contaminant concentration front to arrive at the well (ibid., p. 634). Dispersion and diffusion would cause contaminants to arrive sooner than this estimate.

Based on these estimates, it appears that during the 32 years of prior mill operation that <u>more</u> than sufficient time was available for ore stockpile contaminants to travel to the vicinity of well AMM-1. Although this transport time estimate may appear to be short because it ignores vertical transport to the water table, it is in fact conservative because it also ignores the effects of concentration gradients and aquifer dispersion that would force water table contaminants to arrive even earlier.

Another factor to consider is possible easterly groundwater flow from the leachate mound under the tailings pile, where heads were at least 68 feet higher in the tailings pile than well AMM-1 [Canonie Environmental July, 1994 Report, Figure 4, piezometer B-4(17)]. Unfortunately, Atlas has not installed sufficient numbers of monitoring wells or piezometers at the mill site to confirm gradients between the tailings pile and AMM-1. The NRC should have required such a demonstration of Atlas prior to acceptance of AMM-1 as the "background" well. Such mounding in the water table surface by the tailings pile could have steepened the hydraulic gradients in the vicinity of the ore

stockpile, further accelerating the migration of stockpile contaminants toward the vicinity of well AMM-1.

Due to the late timing of well AMM-1 installation, the lack of shallow aquifer head data in the mill area, the presence of two apparent and highly significant sources of artificial recharge to the water table system, and estimates of apparent advective contaminant transport time from the stockpile to the vicinity of well AMM-1, we cannot conclude with any certainty that well AMM-1 is truly representative of background groundwater quality conditions at the facility.

In order to resolve these uncertainties, Atlas should be required to complete additional characterization of local hydrogeologic conditions , shallow groundwater heads and flow directions, and groundwater quality by installation of several additional monitoring wells across the mill site area. If after this additional geologic, potentiometric, and water quality data are available, Atlas for any reason is unable to justify historic groundwater flow directions and quality, then the NRC must rely on current spatial distribution of tailings contaminants in the shallow aquifer to determine an adequate location for a background groundwater monitoring point. Adequate baseline data for determination of background groundwater quality cannot be provided without resolution of these concerns. **This is an open State issue.** (41) MCL

22. Tailings Leachate Characterization (Section 5.2.5) - review of the DTER shows additional information should be provided regarding the tailings leachate characteristics shown in Table 5-2. This includes a disclosure of the number of samples collected, dates collected, sampling point(s) from which they were collected, type of sample or analysis completed (e.g., total or dissolved analysis), and basic statistics of concentrations measured (minimum, maximum, average and standard deviation).

From DRC review of the NRC docket file, it appears that characterization of the leachate characteristics is limited to only four samples collected by the NRC in 1987 (see 10/27/87 NRC letter by Edward Hawkins). If additional information is available, this should be clearly and completely disclosed. In any case, Atlas should be required to justify why average and standard deviation concentrations presented are representative of past and current leachate conditions in the tailings pile.

The NRC should also include in the DTER comparisons of the average concentration of each contaminant with its applicable groundwater maximum concentration limit (MCL), EPA drinking water MCL, or other health standard. **These are open State issues.** (42) MCL

23. Confirmation of Lateral Containment of Contaminants Via Vertical Hydraulic Gradients Near River (Section 5.2.5) - the NRC has acknowledged that tailings contaminants have been found in the shallow aquifer below the tailings pile (DTER, p. 5-11). Several Atlas reports have also concluded that these contaminants are discharged to the Colorado River. As a result, Atlas should be required to conduct discrete head monitoring within the (43) MC

shallow aquifer [illegible] discharge to the Colorado River.

Part of this information [illegible] 1-S and MW-3 which have been installed in close proximity [illegible] southeast corner of the tailings pile. However, Atlas will need to determine [illegible] intervals of well MW-3 (see July, 1994 Canonie Environmental Report, Table 1). Because well ATP-1-S is screened across the deeper brine flow system, its head measurements will need to be adjusted to freshwater equivalent values after determination of its groundwater specific gravity. Only then can comparison of heads be made between these two wells.

However, if for any reason Atlas is not able to adequately complete this comparison, then the NRC should require installation of nested piezometers or wells to document the upward flow of groundwater near the river. Such piezometers or monitoring wells must be completed in accordance with the EPA RCRA TEGD. **This is an open State issue.** 43

24. <u>Location of Surface Water Sampling Points (Section 5.2.5)</u> - the Atlas surface water sampling locations referred to on page 5-15 are not found on Figure 5-1. 44 MCL

25. <u>Average Contaminant Concentrations (Tables 5-5 and 5-6)</u> - no description is provided with these tables to explain how the average concentrations were calculated. Narrative should also be included to describe the number of samples available and the range and standard deviation of contaminant concentrations described. The DTER should also describe the distribution of these contaminants across the Atlas facility. The NRC should modify the DTER accordingly. 45 MCL

26. <u>Contaminant Concentrations in Seeps on Bank of Colorado River: Need for Additional Non-Radiologic Groundwater Monitoring and Protection Standards (Section 5.2.5)</u> - during the past year the Utah Division of Water Quality (DWQ), in cooperation with DRC, has collected a number of water quality samples from a groundwater seep located on the northern bank of the Colorado River, just west of the mouth of Moab Wash. Hereafter, referred to as the Atlas Tailings Seeps. Three samples collected from the seeps on September 21, 1995, December 7, 1995, and January 18, 1996 were analyzed for a number of inorganic and radiologic parameters. The parameters selected for analysis were chosen from the NRC sampling and analysis of the tailings effluent (10/21/87 NRC letter to Atlas). However, several were omitted for State analysis due to a low likelihood of occurrence in groundwater, as based primarily on extremely low measured concentrations in the 1987 NRC analysis, or their tendency to volatilize. For details on omitted contaminants, see Attachment 9, DRC spreadsheet SEEP.XLS-Inorg, Page 2. 46 MCL

The major ions in these three seep samples were averaged and compared with the average corresponding concentrations in the 1987 tailings effluent samples collected by the NRC. This comparison shows that groundwater from the Atlas Tailings Seeps is a sulfate dominant water (see trilinear diagram in Attachment 10, below). Based on this same

trilinear plot, it appears that the Atlas Tailings Seeps may represent a mixture of tailings leachate and groundwater from the wells found in Arches National Park (ibid.).

Results of the recent DWQ sampling also suggests that the Atlas Tailings Seeps contain groundwater that has been contaminated by tailings effluent, as based on high concentrations of total uranium, molybdenum, vanadium, and other tailings related contaminants (see Attachment 9).

Close review of the average inorganic parameter concentrations shows that groundwater from the Atlas Tailings Seep exceeded one State Groundwater Quality Standard (GWQS) for nitrate + nitrite (10 mg/l). Several other non-radiologic contaminants were also found to have average concentrations above applicable Utah ad hoc GWQS, including: ammonia (as nitrogen, 30 mg/l), manganese (40 ug/l), molybdenum (40 ug/l), and vanadium (60 ug/l). As a minimum, Atlas should be required to monitor for these non-radiologic contaminants in all groundwater monitoring wells at the facility. **This is an open State issue.**

27. <u>Need for Protection of Groundwater Under Adjoining Property: Non-Radiologics (Section 5.2.5)</u> - in light of the six non-radiologic groundwater contaminants found to be in excess of State GWQS, and the potential for their release to adjoining private and public lands, Atlas should be required to include these non-radiologics in their groundwater corrective action plan. If in the event that these or other non-radiologic contaminants have been released to groundwaters under adjoining private and public lands, Atlas should be required to remediate groundwater quality for these non-radiologic parameters under these areas. The objective of such remediation would be to protect the current and future beneficial uses of nearby groundwaters **This is an open State issue.**

28. <u>Water Use and Reports for Trapax Well (Section 5.2.6)</u> - allegations that groundwater in the Trapax well, found east of Atlas well AMM-1, was not "fit for human use" are unsubstantiated by groundwater quality sampling and analysis. In addition, DRC staff review of State water rights records for this well show the application was not filed with the Utah Division of Water Rights until 1992, or 32 years <u>after</u> Atlas began its operations on the site. Doubts also come to play based on possible impacts from the nearby ore storage pile and the tailing pile, described above. Consequently, this reference should be revised accordingly, or removed from the DTER.

29. <u>Integration of Cover Design and Groundwater Protection Standards (Section 5.3)</u> - the ability of the site to meet NRC and State groundwater protection standards is intimately related to the ability of the cover to prevent infiltration and control contaminants within the tailings pile. A cover constructed of earthen materials with excessive permeability will not provide adequate containment of tailings contaminants and cause the groundwater to continue to be polluted by the facility in the future. Nor would such a cover control release of tailings contaminants to the Colorado River. Consequently, the site's ability to

trilinear plot, it appears that the Atlas Tailings Seeps may represent a mixture of tailings leachate and groundwater from the wells found in Arches National Park (ibid.).

Results of the recent DWQ sampling also suggests that the Atlas Tailings Seeps contain groundwater that has been contaminated by tailings effluent, as based on high concentrations of total uranium, molybdenum, vanadium, and other tailings related contaminants (see Attachment 9).

Close review of the average inorganic parameter concentrations shows that groundwater from the Atlas Tailings Seep exceeded one State Groundwater Quality Standard (GWQS) for nitrate + nitrite (10 mg/l). Several other non-radiologic contaminants were also found to have average concentrations above applicable Utah ad hoc GWQS, including: ammonia (as nitrogen, 30 mg/l), manganese (40 ug/l), molybdenum (40 ug/l), and vanadium (60 ug/l). As a minimum, Atlas should be required to monitor for these non-radiologic contaminants in all groundwater monitoring wells at the facility. **This is an open State issue.**

27. <u>Need for Protection of Groundwater Under Adjoining Property: Non-Radiologics (Section 5.2.5)</u> - in light of the six non-radiologic groundwater contaminants found to be in excess of State GWQS, and the potential for their release to adjoining private and public lands, Atlas should be required to include these non-radiologics in their groundwater corrective action plan. If in the event that these or other non-radiologic contaminants have been released to groundwaters under adjoining private and public lands, Atlas should be required to remediate groundwater quality for these non-radiologic parameters under these areas. The objective of such remediation would be to protect the current and future beneficial uses of nearby groundwaters **This is an open State issue.**

28. <u>Water Use and Reports for Trapax Well (Section 5.2.6)</u> - allegations that groundwater in the Trapax well, found east of Atlas well AMM-1, was not "fit for human use" are unsubstantiated by groundwater quality sampling and analysis. In addition, DRC staff review of State water rights records for this well show the application was not filed with the Utah Division of Water Rights until 1992, or 32 years <u>after</u> Atlas began its operations on the site. Doubts also come to play based on possible impacts from the nearby ore storage pile and the tailing pile, described above. Consequently, this reference should be revised accordingly, or removed from the DTER.

29. <u>Integration of Cover Design and Groundwater Protection Standards (Section 5.3)</u> - the ability of the site to meet NRC and State groundwater protection standards is intimately related to the ability of the cover to prevent infiltration and control contaminants within the tailings pile. A cover constructed of earthen materials with excessive permeability will not provide adequate containment of tailings contaminants and cause the groundwater to continue to be polluted by the facility in the future. Nor would such a cover control release of tailings contaminants to the Colorado River. Consequently, the site's ability to

comply with State surface water quality standards is also related to the tailings pile's final engineering design. see discussion below.

After review of the February 8, 1996 Atlas response to the NRC, it is clear that Atlas is intent on taking engineering credit for several final design aspects, in its demonstration that the pile will meet NRC groundwater protection standards (February, 1996 Smith Environmental Technologies Corporation Report, p.6). However, after review of this document we believe that a quantitative performance evaluation of the tailings pile is in order.

To this end, Atlas should be required to provide a quantitative evaluation of the final cover design's performance. Such evaluation must be completed with representative or conservative infiltration and contaminant transport models. The objective of this performance assessment should be to demonstrate that the final engineering design will allow the site to meet NRC and State groundwater and surface water quality standards. After submittal of this performance assessment, either the NRC or the State finds the final engineering cover design insufficient to allow local groundwater or surface water to comply with NRC and State standards, then Atlas should be required to improve the final cover design, as necessary. We believe that the final costs of tailings on-site stabilization cannot be known without this information. Consequently, NRC should require Atlas to complete such a performance assessment before any approval of the Reclamation Plan. This is an open State issue. 49

30. <u>Determination of Groundwater Protection Standards (Section 5.4.1)</u> - **in order for Atlas to complete an evaluation of the cover design to facilitate compliance with NRC and State groundwater protection standards, NRC will need to first determine appropriate groundwater protection standards for the site.** 50

A critical element in selecting appropriate groundwater protection standards is the determination of background groundwater quality. Based on discussions above, all monitoring wells at the facility were installed after about 20 years or more of operation at the site. Consequently, these wells may have been contaminated by historic operations. Furthermore, review of the NRC files shows little effort to define the complete extent of the groundwater contamination at the facility. As a result, it appears that additional monitoring wells and effort will be required to determine the full extent of groundwater contamination at the facility and ensure that the background sampling point(s) are truly outside of the Atlas contamination.

Because groundwater under the Atlas site appears to discharge to the Colorado River, the groundwater protection standards selected by NRC will also need to be closely coordinated with the applicable surface water quality standards. In some cases, the numeric criteria for protection of the Colorado River are of lower concentration than the corresponding groundwater protection standards. In these cases, the surface water quality standards would form the critical path for any performance evaluation of the facility. By

way of information, the State has been delegated primacy under the U.S. EPA National Pollutant Discharge Elimination System (NPDES), and hence has primary responsibility for determination of surface water quality standards.

Accordingly, Atlas should be required to consider all of these factors in determination of applicable groundwater quality protection standards. In deference to State authority over groundwater and surface water quality issues, as they relate to non-radiologic contaminants, the NRC should closely coordinate groundwater protection standards for the Atlas facility with the State. **This is an open State issue.**

50 MCL

31. <u>Need for Performance Assessment (Section 5.4.2)</u> - mention should be made here of the performance assessment needed in order for Atlas to take engineering credit for the cover of the tailings pile in protection of groundwater and surface water quality, and thereby allow cost estimates for on-site stabilization to be completed. In addition, any approval of groundwater alternate concentration limits (ACLs) should be closely coordinated with the State in order to avoid any need for dual regulation of the facility. **This is an open State issue.**

51 MCL

32. <u>Incomplete Evaluation of Points of Exposure (Section 5.4.3)</u> - previous Atlas investigations have failed to acknowledge the possibility of northerly contamination from the tailings pile into Arches National Park. As a result, NRC should require Atlas to evaluate the possibility for adverse impact to ground water quality and human exposure to tailings contaminants to the north in Arches National Park. If groundwater contamination in the National Park is confirmed, NRC should require Atlas to modify its groundwater monitoring and corrective action programs accordingly. **This is an open State issue.**

52 MCL

33. <u>NRC Need to Periodically Update Applicable Groundwater Monitoring Parameters and Protection Standards (Sections 5.4.2, 5.4.3 and Table 5-9)</u> - 10 CFR 40, Appendix A, Criterion 5B(2) provides that a contaminant becomes a "hazardous constituent", and therefore regulated by the NRC at groundwater points of compliance, after said contaminant meets three criteria:

53 MCL

1) Is the contaminant reasonably expected in the byproduct materials (tailings and related wastes),
2) Has the been detected in groundwater in the uppermost aquifer, and
3) Is the contaminant listed in Criterion 13?

As a result, in order for a groundwater protection standard to be set by the NRC, a contaminant must apparently meet all three of these requirements. As explained by NRC staff, this generally involves an evolutionary process where:

1) An initial assessment is made regarding the presence of a Criterion 13 contaminant in the tailings materials (or effluent). Several contaminants were

confirmed in the tailings effluent by sampling undertaken in 1987 by the NRC (10/21/87 NRC letter by Edward Hawkins).

2) Following this initial determination, the contaminant in question must be detected by groundwater monitoring around the facility.

A critical flaw in this approach is that if Atlas is not periodically required to monitor groundwater at the facility for the full suite of Criterion 13 contaminants initially detected in the tailings, then the second condition of Criterion 5B(2) will never be fulfilled. Consequently, Atlas would never be required to expand its groundwater monitoring list as retarded contaminants are latently released from the tailings pile. Nor would the NRC set groundwater protection standards for these latent contaminants. Hence, groundwater and surface water quality at the facility could go unprotected for these contaminants.

In order to prevent this eventuality, Atlas should be required to periodically monitor groundwater quality at the facility for all the contaminants originally tested in the tailings effluent by the NRC in 1987. As new contaminants become detectable in groundwater beneath the tailings pile, then the NRC must set groundwater protection standards accordingly. NRC determination of new GWPS should be closely coordinated with the State in order to ensure consistency with State regulatory requirements, and thereby avoid the need for dual regulation of non-radiologic contaminants. **This is an open State issue.** 53

34. NRC Shortcomings in Determination of Groundwater Protection Standards (Section 5.4.3 and Table 5-9) - during DRC review of records found in the NRC docket file we have found several shortcomings regarding the NRC's application of Criterion 5 to the Atlas facility. See discussion below.

A. NRC Neglected Known Tailing Contaminants - DRC review of NRC docket file shows that two Criterion 13 contaminants were detected by NRC in the 1987 Atlas tailings effluent sampling but were not included in the detection monitoring program required by the June 15, 1988 NRC Radioactive Materials License, Amendment No. 1, see summary in Attachment 7 below. Review of the October 21, 1987 NRC Letter from Edward F. Hawkins to Atlas Minerals, shows that fluorine (fluoride) and thallium were both detected by total analysis of the tailings effluent, but were excluded as detection monitoring parameters in the June 15, 1988 Radioactive Materials License. Unfortunately, our review of related NRC documents failed to provide any explanation for the neglect of these two contaminants. **This is an open State issue.** 54 MCL

B. Determination of Additional "Hazardous Constituents" under NRC Criterion 13 - 10 CFR 40, Appendix A, Criterion 13 allows the NRC to determine other contaminants to be hazardous, other than those listed therein. Several contaminants not currently listed in Criterion 13 have been found by NRC in the Atlas tailings effluent (October 21, 1987 NRC Letter to Atlas Minerals). Many 55 MC

of these contaminants today have human health criteria, i.e., EPA drinking water MCLs or health advisories, which NRC should consider in order to protect groundwater quality at the facility. These contaminants and their MCLs are listed in Table 2, below.

In order to avoid the need for State regulation of the Atlas facility, these non-radiologic contaminants should be identified by the NRC as hazardous constituents and corresponding groundwater protection standards added to the Atlas Radioactive Materials License. Additional evaluation may also be needed to ensure that the numeric levels presented in Table 2, above pose no threat to surface water quality in the Colorado River, see discussion below. **This is an open State issue.**

55 MCL

Table 2. Known Atlas Tailings Contaminants: Proposed Groundwater Protection Standards

Contaminant	Proposed Groundwater Protection Standard	Source of EPA Standard/Health Limit
Ammonia	30 mg/l	Draft Lifetime Health Advisory (1)
Antimony (3)	0.006 mg/l	Final MCL (2)
Beryllium	0.004 mg/l	Final MCL
Boron (3)	0.6 mg/l	Draft Lifetime Health Advisory
Fluoride (3)	4 mg/l	Final MCL
Manganese	0.05 mg/l	Secondary MCL
Molybdenum	0.04 mg/l	Draft Lifetime Health Advisory
Nickel	0.1 mg/l	Final MCL
Nitrate (as N) (4)	10 mg/l	Final MCL
Nitrite (as N) (4)	1 mg/l	Final MCL
Nitrate+Nitrite (as N) (4)	10 mg/l	Final MCL
Thallium	0.002 mg/l	Final MCL
Zinc	2 mg/l	Final Lifetime Health Advisory

Footnotes:

1) EPA drinking water lifetime health advisories from EPA Office of Water document entitled "Drinking Water Regulations and Health Advisories", November, 1994.

2) EPA drinking water maximum contaminant levels found in 40 CFR 141 and EPA Office of Water November. 1994 document entitled Drinking Water Regulations and Health Advisories

3) Antimony, boron, and fluoride are suspect tailings contaminants due to suspicions caused by NRC use of inadequate analytical methods, wherein lower limits of detection (LLD) used were greater than the corresponding EPA MCL or health limit. In the case of fluoride, the LLD of 100 mg/l grossly exceeds the EPA drinking water MCL of 4 mg/l

4) Nitrate and nitrite are suspect contaminants in the Atlas tailings effluent due to: 1) NRC selected inadequate lower limits of detection for these parameters, 500 and 100 mg/l respectively, which were grossly in excess of their corresponding EPA drinking water MCL, and 2) both nitrate + nitrite (as N) are expected to be in excess of the EPA 10 mg/l limit based on the exceedingly high ammonia (as high as 2,400 mg/l - dissolved) and total kjeldahl nitrogen (as high as 1,560 mg/l - total) concentrations reported in the October 21, 1987 NRC letter to Atlas Minerals.

B. <u>Possible NRC Failure to Discover Certain Tailings Contaminants</u> - several other parameters are suspect tailings contaminants because NRC used inadequate analysis methods, in that their lower limits of detection were greater than their corresponding EPA MCL or relevant health limit values. As a result, these contaminants may have been mistakenly disregarded during the 1987 NRC discovery process. These contaminants are summarized in Table 3, below.

Table 3. Tailings Contaminants Possibly Undiscovered Due to Inadequate LLDs

Contaminant	Groundwater Protection Standards (mg/l)		1987 NRC Lower Limits of Detection for Tailings Effluent Analysis, mg/l [1]	
	10 CFR 40, Appendix A Table 5C	State Proposed	Dissolved Analysis	Total Analysis
Antimony		0.006	2.0	5.0
Boron		0.6	0.8	2.0
Lead	0.05		2.0	5.0
Molybdenum		0.04	0.4	1.0
Nickel		0.1	0.6	1.5
Silver	0.05		0.5	1.2

Footnote: 1) October 21, 1987 NRC letter from Edward Hawkins to Atlas Minerals.

Review of the NRC docket file shows Atlas proposed to include molybdenum as a groundwater detection monitoring parameter. Later NRC acknowledged its poor detection limits and added lead, nickel, and silver as detection monitoring parameters in the June 15, 1988 Radioactive Materials License, Amendment No.

1 (June 15, 1988 NRC transmittal letter from R. Dale Smith to Atlas Minerals). However, the NRC docket file does not provide an explanation for why the remaining two contaminants with poor detection limits, antimony and boron, were excluded as detection monitoring parameters in the License.

Discussions with NRC staff have indicated that Criterion 7 may allow the NRC to require Atlas to sample and analyze tailings leachate and/or groundwater in order to resolve these concerns. The NRC should justify their earlier determination to drop these contaminants from the required monitoring, or require Atlas to sample and analyze the tailings leachate for these parameters. In any case, these non-radiologic contaminants should be included as groundwater protection standards under the Atlas Radioactive Materials License. **This is an open State issue.** (56) MCL

C. <u>NRC Failure to Adequately Justify Elimination of Hazardous Constituents and Failure to Set Appropriate Groundwater Protection Standards</u> - NRC Criterion 7A states that the purpose of detection monitoring is to detect leakage of hazardous constituents from the disposal area. The NRC determined 29 hazardous constituents for the detection monitoring program in issuance of the June 15, 1988 Radioactive Materials License, Amendment No. 1. (57) MCL

Criterion 5B(1) also requires the NRC to determine groundwater protection standards when detection monitoring indicates leakage of hazardous constituents from the disposal area. Criterion 5B(5) requires the NRC to set groundwater protection standards for hazardous constituents at the points of compliance. These determinations were made by the NRC in the December 14, 1988 Radioactive Materials License, Amendment No. 4.

Comparison of the hazardous constituents identified in the June 15, 1988 Radioactive Materials License, Amendment No. 1 with those listed for the compliance monitoring program required under Amendment No. 4 suggests that the NRC <u>decreased</u> the number of hazardous constituents from 29 to 17 parameters, see Attachment 7 below. This decrease in the number of hazardous constituents (and subsequent compliance monitoring parameters and groundwater protection standards) is not unprecedented in that Criterion 5B(3) allows NRC on a case-by-case basis to exclude detected contaminants, if it can be shown that the discounted "... constituent is not capable of posing a substantial present or potential hazard to human health or the environment."

In determination of such potential hazards, Criterion 5B(3) requires the NRC to consider a lengthy list of potential adverse effects on groundwater and surface water quality, as follows:

1) Potential Adverse Effects on Groundwater Quality - considering:

a) Physical and chemical characteristics of the waste and its potential for migration.
b) Hydrogeological characteristics of the facility and surrounding land,
c) Quantity of groundwater and direction of groundwater flow,
d) Proximity and withdrawal rates of groundwater users,
e) Current and future uses of groundwater in the area,
f) Existing quality of groundwater, including other sources of contamination and their cumulative impact on groundwater quality,
g) Potential for health risks caused by human exposure to waste constituents,
h) Potential damage to wildlife, crops, vegetation, and physical structures caused by exposure to waste constituents,
i) Persistence and permanence of the potential adverse effects.

2) Potential Adverse Effects on Hydraulically-Connected Surface Water Quality - considering:

a) Volume, and physical and chemical characteristics of the waste,
b) Hydrogeological characteristics of the facility and surrounding land,
c) Quantity and quality of groundwater and direction of groundwater flow,
d) Patterns of rainfall in the region,
e) Proximity of licensed site to surface waters,
f) Current and future uses of surface water in the area, and any water quality standards established for those surface waters,
g) Existing quality of surface water, including other sources of contamination and their cumulative impact on surface water quality,
h) Potential for health risks caused by human exposure to waste constituents,
i) Potential damage to wildlife, crops, vegetation, and physical structures caused by exposure to waste constituents,
j) Persistence and permanence of the potential adverse effects.

DRC review of NRC docket file has failed to locate any NRC evaluation of the above groundwater and surface water considerations which would have justified the elimination of any of the 29 original hazardous constituents found in the detection monitoring program. Furthermore, we have also been unable to locate any NRC justification for the determination of only 9 groundwater protection standards among the 17 compliance monitoring parameters required by Atlas License Amendment Number 4, see summary in Attachment 7, below.

A NRC staff memorandum found in the NRC docket file, further reinforces this problem. The NRC docket file shows that NRC staff determined groundwater protection standards for 19 contaminants at the Atlas facility, among which were 10 parameters of interest: acetone, arsenic, barium, beryllium, cadmium, cyanide, lead, methylene chloride, silver, and thorium-230 (December 13, 1988 NRC staff Memorandum from Gary R. Konwinski to Docket File No. 40-3453, Table 1). This would imply that the NRC staff had determined these 19 contaminants to be "hazardous constituents", pursuant to NRC Criteria 5B(1) and 5B(5).

However, upon issuance of Radioactive Materials License Amendment No. 1, dated the next day (December 14, 1988), groundwater protection standards had been set for only 9 of the 19 "hazardous constituents". This left groundwater at the Atlas facility unprotected for the 10 contaminants apparently identified by NRC staff as "hazardous constituents".

Review of the current Radioactive Materials License, Amendment No. 26, dated January 22, 1996, shows neither the total number or types of groundwater compliance monitoring parameters has changed, nor the assigned groundwater protection standards and their respective numeric limits been modified since 1988. Based on the lack of documentation in the NRC docket file it appears that the current groundwater compliance monitoring parameters and protection standards for the Atlas facility are unjustified.

As a result, the NRC should re-evaluate and formally justify previous decisions regarding the number and type of groundwater compliance monitoring parameters and protection standards at the Atlas facility. The NRC should also re-evaluate groundwater protection standards for the facility, and re-establish new parameters and numeric levels as necessary, in close cooperation with the State. We would expect that this re-evaluation would include:

1) New sampling and analysis of groundwater quality at the facility to determine the presence of known tailings contaminants that may have previously gone undetected in the shallow aquifer, and

2) Justify any omitted groundwater compliance monitoring and/or protection standard parameter after a complete and thorough evaluation of potential adverse effects to groundwater and surface water quality, pursuant to NRC Criterion 5B(3).

Without resolution of this issue, it appears the NRC would be unable to demonstrate protection of groundwater or surface water quality at the facility. Consequently, we do not believe that the NRC can approve the Atlas final engineering design or Reclamation Plan without satisfactory resolution of these issues. **These are open State issues.**

57 MCl

D. <u>Revision After Determination of Background Conditions (Table 5-9)</u> - after resolution of appropriate locations from which background groundwater quality is determined for the facility, and determination of background ground concentrations at these points, NRC should revise the groundwater protection standards determined in the Atlas License, and as listed in DTER Table 5-9. **This is an open State issue.**

E. <u>Groundwater Contaminants Regulated by State: Proposal for Hazardous Constituent Status</u> - NRC Criterion 13 allows case-by-case determination of other contaminants, not listed in Criterion 13, as "hazardous constituents". Thanks to such a designation, said contaminants could be regulated at a Title II facility and groundwater protection standards established under a NRC Radioactive Materials License. In addition to those contaminants identified above, several other pollutants have been detected in the Atlas tailings effluent which are regulated by the State for the purpose of groundwater protection, but which are not identified as hazardous constituents by the NRC, nor provided groundwater protection standards under the Atlas Radioactive Materials License. These contaminants are listed in Table 4 below.

Table 4. State Regulated Contaminants Proposed for Hazardous Constituent Status

Contaminant	State GWQS [1]
Copper	1.3 mg/l
pH	6.5 - 8.5
Total Dissolved Solids	TBD[2]

Footnotes:

1) GWQS = Ground Water Quality Standards established in Utah Ground Water Quality Protection Regulations, Utah Administrative Code (UAC), R317-6-2, Table 1.

2) To be determined. GWQS established for total dissolved solids (TDS) based on background groundwater concentrations for TDS and groundwater classification set for facility during issuance of State Ground Water Discharge Permit.

In order to avoid the need for State regulation of the Atlas facility, we request that the NRC identify the three contaminants in Table 4, above, as hazardous constituents and establish corresponding groundwater protection standards under the Atlas Radioactive Materials License. **This is an open State issue.**

35. <u>Need to Establish a Groundwater Corrective Action Monitoring Program (Section 5.4.3)</u> - Atlas has been required to implement a groundwater corrective action program (December 14, 1988 Radioactive Materials License, Amendment No. 4, Condition 17C). Relevant to this, NRC Criterion 7 requires:

"In conjunction with a corrective action program, the licensee shall establish and implement a corrective action monitoring program. The purpose of the corrective action monitoring program is to demonstrate the effectiveness of the corrective actions. Any monitoring program required by tg [sic] his paragraph may be based on existing monitoring programs to the extent the existing programs can meet the stated objective for the program."

DRC review of NRC docket file has failed to locate any Atlas submittal or NRC approval of such a groundwater corrective action monitoring program. Furthermore, it appears that the past and current Atlas groundwater monitoring program cannot ascertain with assurance "... the effectiveness of the corrective actions.", pursuant to Criterion 7, based on concerns and deficiencies listed above, including but not limited to:

A. Incomplete hydrogeologic characterization of both the mill and tailings sites,

B. Lack of sufficient potentiometric data to justify assumed groundwater flow directions across both the mill and tailings sites,

C. Incomplete and unjustified list of hazardous constituents for groundwater monitoring.

D. Lack of quality assurance criteria for groundwater monitoring well placement and construction,

E. Lack of quality assurance criteria for past groundwater quality sampling, sample preservation, and analysis,

F. Erratic groundwater monitoring results found in historic Atlas environmental monitoring reports,

G. Lack of NRC verification of Atlas groundwater monitoring results thru independent sampling and analysis.

Based on these findings and the requirements of Criterion 7, it is apparent that the NRC should require Atlas to re-evaluate and revise their current groundwater monitoring of the facility thru submittal of a groundwater corrective action plan that will address all of the State issues listed above. After NRC review and approval, Atlas should be required to immediately implement the approved plan. **This is an open State issue.**

(60) MCL

36. <u>NRC Failure to Impose Groundwater Corrective Action Plan Performance Requirements Mandated by Criterion 5D (Section 5.4.3)</u> - DRC review of the NRC docket file shows that the NRC has relaxed its initial License performance requirements for the Groundwater Corrective Action Plan (GWCAP). As a result, the current License is in

(61) MC

violation of NRC Criterion 5D, which requires groundwater corrective action programs to:

> "... return hazardous constituent concentration levels in ground water to the concentration limits set as standards." (10 CFR 40, Appendix A, Criterion 5D)

Project history shows the first License amendment where the NRC required a GWCAP, the License complied with Criterion 5D, in that it mandated Atlas to:

> "Implement a corrective action program due to the exceedance of ground-water protection standards, with the objective of returning the concentrations of chromium, gross alpha, molybdenum, nickel, radium-226 and 228, selenium, uranium, and vanadium to the concentration limits specified in Subsection (B)." [see December 14, 1988 NRC License Amendment No. 4, License Condition 17(C)]

Subsection B of the License is where the groundwater protection standards were located. In concept, we agree with the December, 1988 NRC approach because it is consistent with NRC Criterion 5D, and it represents an effort to protect important groundwater resources.

However, this performance objective for the GWCAP was later removed by the NRC, and supplanted with only a requirement that Atlas:

> "... submit a corrective action program review by December 31, of each year, that describes the progress towards attaining ground-water protection standards." [July 18, 1989 NRC License Amendment No. 8, Condition 17(C)].

Review of the NRC docket file has failed to find any justification for the removal of this performance objective. Furthermore, this change appears to be in direct contradiction to NRC Criterion 5D, in that it does not mandate Atlas to return groundwater quality in the compliance monitoring wells to the groundwater protection standard concentrations; but only to report their progress toward that end. No time limits have been imposed in the license, by which Atlas is to achieve compliance with the groundwater protection standards in the License. Unfortunately, this is the same language found in the current License [January 22, 1996 NRC License Amendment No. 26, Condition 17(C)].

As a result, no performance objective currently exists in the License for the GWCAP. Consequently, the current license fails to comply with NRC Criterion 5D. Furthermore, no deadlines have been imposed in the License by which Atlas could be required to complete restoration of local groundwater quality. Therefore, NRC should modify the existing License to re-instate the previous performance criteria for the GWCAP that will

mandate Atlas to regain and maintain the groundwater protection standards in their compliance monitoring wells. A deadline for completion of this groundwater restoration must be determined and also imposed by the License. **This is an open State issue.**

61 MCL

37. <u>NRC Failure to Enforce GWCAP Performance Objectives Mandated by Criterion 5D: Need to Require Active Groundwater Remediation (Section 5.4.3)</u> - thanks to the removal of Criterion 5D performance objectives for the GWCAP, Atlas is no longer required to return groundwater quality in the compliance monitoring wells to the groundwater protection standards. Nor has NRC enforced the performance criteria for groundwater corrective action found in Criterion 5D. This is of great concern, in that recent Atlas groundwater monitoring results from compliance wells AMM-2 and AMM-3 show groundwater quality has been seriously degraded. Several tailings contaminants have been found in these and other wells that grossly exceed the groundwater protection standards set forth in the License.

62 MCL

While we acknowledge apparent decreasing trends in some monitoring wells, recent measurements still indicate gross exceedance of groundwater protection standards. Examples of this problem include uranium concentrations measured by Atlas at over 2,000 and 1,500 pCi/l in compliance monitoring wells AMM-2 and AMM-3, respectively (July, 1994 Canonie Environmental Report, Appendix D, Graphs D-10 and 11). Recently, even higher uranium concentrations have been found in nearby well ATP-2-S, at more than 3,000 pCi/l (ibid., Graph D-12). These contaminant concentrations are enormous in comparison to either the License mandated 4.0 pCi/l groundwater protection standard [License Condition 17(B)], or the recently promulgated 30 pCi/l EPA groundwater standard for Title I uranium mill sites (40 CFR 192 Subpart A, Table 1), in that they exceed these limits by <u>orders</u> of magnitude.

Due to these massive concentrations, it appears that simple covering of the tailings pile combined with a "natural flushing" approach to groundwater remediation would render nearby groundwater unusable for very long periods of time, perhaps even centuries. Unsubstantiated estimates by Atlas have predicted at least 75 years would be needed to remediate nearby groundwater to the EPA 30 pCi/l uranium groundwater standard (March, 1989 Western Technologies Report, p. 34). Perhaps much longer periods of time will be necessary for reduction of other more retarded radioactive and non-radioactive contaminants to acceptable levels in the groundwater system. In a similar vein, it may take comparable lengths of time to reverse apparent adverse impacts to surface water quality, a problem discussed below.

It is clear that the Atlas attempt at de-watering the tailings and evaporating the leachate was not completely effective in returning groundwater quality to compliance with the License's groundwater protection standards (DTER, pp. 5-22 and 23). Of late, Atlas has abandoned its groundwater corrective action project in order to construct a tailings pile cover. However, serious State concerns exist regarding the efficacy of covering the tailings as the sole groundwater corrective action remedy. The NRC has retracted its

earlier performance standard for the GWCAP, which would have required Atlas to regain compliance with the groundwater protection standards of the License. Consequently, Atlas is no longer mandated by License to remediate groundwater quality in compliance with NRC Criterion 5D. Although several active groundwater corrective action measures have been found to be cost effective by the NRC (DTER, p. 5-21), no methodology or deadlines have been imposed in the License, within which the groundwater is to be restored to acceptable concentration limits. Finally, the NRC openly admits that a groundwater contamination problem exists, and that to date Atlas "... has not implemented any corrective action to directly reduce the contaminant levels in the uppermost aquifer." (DTER, p. 5-23). Based on this history and lack of action to protect groundwater and surface water resources near the tailings pile, the State is concerned about when, if any groundwater corrective action, will be completed at this facility.

As a result of these concerns, Atlas should be required to implement active groundwater corrective action measures that will protect current and future beneficial uses of both ground and surface waters near the facility. Focus should be placed not only on groundwater under the Atlas property, but on ground and surface water resources under and on adjoining private and public lands. Therefore, the NRC should act to require such measures of Atlas without delay. **This is an open State issue.**

38. Need to Coordinate Approval of Revised GWCAP and ACLs with State: Non-Radiologics (Section 5.5) - in light of the shortcomings listed above, it is clear that the current Atlas GWCAP is in need of revision. Discussion with NRC staff has indicated that the agency is underway in its process of re-evaluating the currently approved Atlas GWCAP, as it is embodied in the July, 1994 Canonie Environmental Report. The State also has jurisdiction over groundwater quality and groundwater corrective action programs, as found in the Utah Ground Water Quality Protection Regulations (UAC R317-6). It is also clear that the State has jurisdiction in the issue of non-radiologic contaminants at Title II uranium mill sites.

Consequently, we suggest that the NRC closely coordinate its review and re-evaluation of the Atlas GWCAP with the State, so as to ensure the regulatory needs of both agencies are met. During State review of any GWCAP, close attention will be given to characterization of site hydrogeological conditions, pollutant concentrations and extent in the aquifer, environmental fate of groundwater contaminants, nearby groundwater and surface water rights and uses, thorough assessment of human and environmental risk, and application of best available technology in containment and control of tailings contaminants.

Discussions with NRC and Atlas staff have also indicated that Atlas intends to apply for groundwater Alternate Concentration Levels (ACL) in a future revision of the GWCAP. Under State groundwater quality regulations, the approval of groundwater ACL is reserved only for the Utah Water Quality Board (UAC R317-6). Consequently, close coordination with the State is also in order for proposed ACLs. During such State review,

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DEQ staff will focus on compliance of any proposed ACL with State groundwater quality standards (UAC R317-6) and surface water quality standards (UAC R317-2) found in the Utah Water Quality Regulations, and implementation of best available technology for the engineered cover system.

Based on the State's technical concerns regarding the GWCAP, many of which are listed above, it appears that serious revision of the Atlas GWCAP is necessary. If dual regulation of the Atlas facility is to be avoided, it is then in the best interest of both the NRC and the State to closely coordinate review and approval of the final Atlas GWCAP. We would hope that such a coordinated effort is possible, and our concerns regarding the current and soon to be revised GWCAP can be resolved. **These are open State issues.** 63 MCL

39. Need for NRC Assessment of Surface Water Quality (New Section) - the DTER should not only focus on groundwater quality, but also include an assessment of the effect of the tailings pile on surface water quality. Statements made by NRC and Atlas staff to State personnel have indicated that Atlas plans on applying for groundwater Alternate Concentration Limits (ACLs) as an integral part of their GWCAP. A key element that the NRC must consider is the current and future impact of the tailings pile on water quality in the Colorado River. This evaluation must be included in any considerations of pile cover design, and should be a part of the DTER. **This is an open State issue.** 64 MCL

40. State Findings of Apparent Adverse Effect of Tailings Pile on Colorado River, and Recommendation for Additional Evaluation (New Section) - during the past year the Utah Department of Environmental Quality (DEQ) has undertaken a focused study of water quality conditions in the Colorado River immediately above and below the Atlas tailings pile. During this time period, water quality grab samples were collected for heavy metals, radiologics, nutrients, and general chemistry and field parameters. Upstream samples were collected at the U.S. Highway 191 crossing of the Colorado River (Moab Bridge). Downstream river samples were collected immediately below and south of the Atlas tailings pile where State Road 279 (Potash Road) first encounters the Colorado River (approximately 2,500 feet East and 1,800 feet North of the Southwest corner of Section 34, Township 25 South, Range 21 East, USBM). Samples were collected by staff of the Utah Division of Water Quality (DWQ). Analyses were completed by the Utah State Health Laboratory. Results of the State's river water quality sampling are found in Attachments 11 (upstream results) and 12 (downstream results), below.

As can be seen in Attachments 11 and 12, a large number of water quality parameters were sampled during the State's study. In order to streamline evaluation of the results, DRC staff focused on the tailings contaminants most likely to be transferred from the contaminated groundwater to the Colorado River. These largely included those mobile non-radiologic parameters found in the Atlas Tailings Seep samples, which were in excess of the Utah Ground Water Quality Standards, see discussion above. Included with these contaminants were: ammonia (as nitrogen), manganese (dissolved and total), molybdenum (dissolved and total), nitrate + nitrite (as nitrogen), and vanadium (dissolved

and total). Results of [illegible] summary spreadsheet in Attachment [illegible].

A. <u>Ammonia</u> [illegible] the Atlas tailings pile were below [illegible] However, below the tailings pile the average ammonia concentration [illegible] greater (0.53 mg/l). Although only two sampling events were included so far in this study, on both occasions, November 15 and December 7, 1995, the downstream ammonia concentrations were greater than their upstream counterparts. This is not unexpected, in that ammonia is a known tailings contaminant (10/21/87 NRC letter to Atlas), and concentrations as high as 300 mg/l were found by DEQ in the Atlas tailings seeps (see Attachment 9, below). These in-stream ammonia concentrations found by DEQ suggest that the Atlas tailings pile may be a local source for ammonia loading in the Colorado River.

Comparison of these ammonia data with the Utah Water Quality Standards shows the December 7, 1995 downstream ammonia value was about 206% above the State in-stream water quality standard. This ammonia standard for aquatic wildlife, 0.44 mg/l, was determined by DRC and DWQ staff pursuant to the Utah Water Quality Regulations (Utah Administrative Code R317-2), and consideration of average temperature and pH seen at the upstream sampling point (see Attachment 13, below). These elevated and apparent excess ammonia concentrations found in the Colorado River below the Atlas tailings pile may have adverse effect on aquatic wildlife.

As a result, Atlas should at least be required to conduct additional ammonia (as nitrogen) sampling to form a more statistically valid data set and to asses this apparent local adverse impact of Colorado River water quality. With this in mind, ammonia should also be included as a contaminant of concern in all future groundwater characterization and protection efforts.

In addition, the elevated ammonia content at the downstream location may indicate that this location is still within the "mixing zone" below the Atlas tailings pile. Additional water quality sampling downstream from this point may be helpful in determining the full extent of this mixing area in the river's channel.

65 MC

B. <u>Manganese (dissolved and total)</u> - elevated total manganese concentrations were seen in two upstream river samples (6/29/95 and 9/21/95). However, in two cases total manganese concentrations increased between the up and downstream sampling point by factors of 127% and more than 780%, respectively (8/10/95 and 9/21/95).

As for dissolved manganese, slight decreases were seen in two sampling events between the up and downstream points (11/15/95 and 1/18/96). A third sampling

66 MC

event, however, showed a 730% increase in dissolved manganese concentration (12/7/95). Average dissolved manganese concentrations show a 342% increase in the downstream direction.

In general, there appears to be a greater tendency in the data for manganese concentration increases in the downstream direction. Consequently, manganese may also be a key indicator of tailings contamination. Additional water quality samples should be collected to evaluate manganese loading on the Colorado River.

66 MC

C. Molybdenum (dissolved and total) - only one sampling event during the study included total molybdenum (9/21/95). The results of this work show no apparent change in total molybdenum concentrations between upstream and downstream locations.

67 MC

However, dissolved molybdenum samples did show increased concentrations at the downstream location for both samples collected. These samples, collected on December 7, 1995 and January 18, 1996, show downstream increases of 825% and 150% respectively over their upstream counterparts. In general, the average dissolved molybdenum concentration did show a 488% increase in the downstream direction.

Of greater concern, however, is the apparent violation of the State molybdenum water quality criteria at the downstream location seen in the December 7, 1995 sampling event. In this case, the downstream location had a dissolved molybdenum concentration of 33 ug/l, or 330% over the State water quality criteria (10 ug/l). As a result, Atlas should at least be required to conduct additional molybdenum sampling to form a more statistically valid data set and to asses this apparent local adverse impact of Colorado River water quality.

D. Nitrite + Nitrate (as Nitrogen) - upstream concentrations were found to be rather low ranging from 0.37 to 0.43 mg/l. However, small increases in nitrite + nitrate concentrations were seen at the downstream location. Comparison of average concentrations shows that nitrite + nitrate increased by 139% in the downstream direction. Due to their relationship of these contaminants to ammonia, both nitrite and nitrate sampling should be conducted in concert with any additional ammonia sampling of the river or groundwater.

6 MC

E. Vanadium - vanadium concentrations were found undetectable both above and below the Atlas tailings pile. This suggests that: 1) vanadium for some reason does not enter the river, even though it has been found in the Atlas Tailings Seep samples, or 2) more precise analytical methods are needed to measure vanadium concentrations in the river water. We recommend that Atlas be required to collect additional vanadium samples for river water quality assessment, and employ better

6 M

analytical techniques in order to complete assessment of vanadium loading on the Colorado River.

Although the data set recently collected by the State is meager in size, it appears to point to the Atlas tailings pile as a source of contaminant loading in the Colorado River for a number of heavy metals and nutrients. Consequently, Atlas should at least be required to complete a thorough, detailed, and statistically valid study of the impact of tailings leachate and discharge on the local water quality of the Colorado River. Such assessment should evaluate potential for adverse impact on all current and future uses of the Colorado River, and compliance with State Water Quality Standards and numeric criteria. This information then needs to be integrated with the engineering design plans for the final embankment cover, and Atlas required to demonstrate that the final cover design will allow the local stretch of the Colorado River to obtain and maintain compliance with State Water Quality Standards and numeric criteria.

If after these additional studies are available, either the NRC or the State determine that changes are necessary in the engineering design to protect Colorado River water quality, Atlas should be required to modify its engineering design accordingly. After resolution of this issue, Atlas should be required to conduct ongoing monitoring of local Colorado River water quality in order to confirm compliance with State Water Quality Standards and numeric criteria.

10 CFR 40, Appendix A, Criterion 6(7) requires Atlas to "... address the non-radiologic hazards associated with the wastes in planning and implementing closure." Control of all non-radiologic contaminants from the tailings pile, including those listed above, is important to the protection of human health and the environment. Consequently, we believe that the final engineering design and Reclamation Plan for the Atlas tailings pile cannot be completed or approved by NRC without resolution of the apparent impacts of non-radiologic contaminants on surface water quality. **This is an open State issue.**

41. <u>Need For Final Engineered Cover to Comply With Colorado River Salinity Standards (New Section)</u> - in order to protect Colorado River water quality, Atlas has a responsibility to comply with the Colorado River Salinity Standards found in the Utah Standards of Quality for Waters of the State (UAC R317-2-4). These salinity standards have been adopted by Utah in cooperation with the other Colorado River basin states, and the U.S. EPA (Colorado River Basin Salinity Control Forum Policy). Said standards apply to industrial point source discharges of pollutants to the Colorado River. Under these salinity standards, dischargers have a responsibility to comply with a "no-discharge" performance goal, to the extent practicable, for salts and total dissolved solids (TDS). Generally, compliance with this goal is achieved through engineering controls to prevent contaminant discharges to the river.

In the case of existing industrial facilities, such as the Atlas tailings pile, the salinity standard allows a minimal discharge of salts when the facility can successfully

demonstrate "... that it is not practicable to prevent the discharge of all salt from an existing facility. Such a minimal discharge rate is then required to undergo technical justification, part of which include a cost analysis for salt minimization. However, such technical justification and the "no-discharge" requirement may be waived on a case-by-case basis where the total salt or TDS load to the river is less than one ton (2,000 lb) per day or 350 tons per year, whichever is less.

DRC review of available Atlas hydrogeologic data and recent DEQ groundwater quality information suggests that the Atlas facility has discharged salts (TDS) to Colorado River in large excess of 2,000 lb/day limit (see Attachment 14, below). Based on average aquifer hydraulic gradient and conductivity, and average groundwater TDS conditions, it appears that at least 4,312 lb/day of salts are released daily by the Atlas facility to the river. After consideration of the vertical extent of apparent tailings contamination in the shallow aquifer, this daily salt discharge could be as high as 15,523 lb/day. Such estimates suggest that daily discharge of contaminated groundwater from the Atlas facility to the river are between 200% to nearly 800% above the 2,000 lb/day waiver limit set by the Colorado River Salinity Control Forum Policy.

After careful review and coordination with the Utah Division of Water Quality, it is the State's conclusion that the Atlas tailings pile should be required to meet the Colorado River Salinity Standards.

This means that Atlas should be required to demonstrate the effectiveness of the final engineered cover to reduce the discharge of TDS and tailings contaminants to the Colorado River. At a minimum, this demonstration needs to include representative or conservative measurements of:

1) <u>Daily Groundwater Discharge to the Colorado River</u> - that will result from the construction of the final tailings pile cover. This should include representative measurements of hydraulic gradient, aquifer permeability, and thickness of the contaminated zone within the shallow aquifer. Groundwater head data needed for the determination of hydraulic gradient may be conservatively selected from historic measured values within the tailings pile, or predicted by infiltration and/or groundwater flow models.

2) <u>Groundwater TDS Concentration Data</u> - from groundwater contaminated by the Atlas tailings pile that is and will be discharged to the river. Evaluations must be made regarding the spatial distribution of contaminated groundwater quality, including maximum, minimum, and average concentrations within the contaminant plume. Estimates for future TDS concentration levels within the plume may also be necessary.

71 MCL

In order to avoid dual regulation of the Atlas tailings pile, the NRC should require Atlas to make this demonstration, and show that the final engineered cover will comply with the State Salinity Standards. **This is an open State issue.** 11 MCL

Comments on Radon Attenuation and Site Cleanup (Section 6.0)

42. Depth of Ra-226 Characterization in Tailings (Section 6.2.2) - the NRC states that the Atlas radon emanation model is sensitive to radium-226 concentrations in the upper 15 feet of the tailings (DTER, p. 6-5). However, the NRC then contradicts its determination with the statement that Atlas only need to determine radium-226 concentrations to a depth of three to four feet (ibid.). The NRC should avoid such inconsistency and ensure that radium-226 concentrations are characterized to the depth for which the radon emanation model is sensitive. **This is an open State issue.** 72 ESB

43. Atlas Testing and NRC Prior Approval for "Affected Soils" (Section 6.2.2) - the "affected" soils placed below the clay radon barrier are integral to control of radon emanations from the tailings pile. Consequently, the NRC should require demonstration and prior approval of their radium-226 content before any clay radon barrier construction. Because radium-226 is preferentially partitioned by fine-grained soils, the NRC should require Atlas to include sieve analysis with all radium-226 testing of soils to determine the gradation of each soil sample reported. If during this demonstration, radium-226 concentrations are found to be greater that acceptable levels, NRC must require Atlas to redesign their clay radon barrier thickness accordingly. **This is an open State issue.** 73 ESB

44. Testing Frequency for "Affected Soils" (Section 6.2.2) - the Atlas proposal listed 15 samples to be collected for a layer of soil material that has been proposed to be a minimum of 16 inches thick (DTER, p. 6-6 and Figure 6-1). Based on the topslope area of the tailings pile of 91 acres (DTER, p. 6-9) and a minimum thickness of 16 inches, these 15 samples equate to no more than one sample per 13,017 cubic yards of material. If Atlas finds more "affected soil" to cleanup around the mill site, these 15 samples will be diluted across an even greater volume of soil material. In contrast, NRC has required gradation testing for the filter and riprap materials on a frequency of at least one sample per 10,000 cubic yards (DTER, p. 4-24). We believe that radium-226 testing of these cover materials is at least as important, if not more so, than the material gradation testing. Consequently, the NRC should require radium-226 testing on at least the same frequency as the filter and riprap materials, i.e., at least one sample per 10,000 cubic yards of "affected soil". **This is an open State issue.** 74 ESB

45. Atlas Plan for Sampling Moab Wash Sandy Soils: Soil Gradation Analysis (Section 6.2.3) - Moab Wash sandy soils are proposed to be used for the filter layer over the clay radon barrier. The DTER then refers to an Atlas plan for sampling these soils to determine background conditions for radium-226 (p. 6-7). DRC staff review of this plan, found in the Canonie Environmental March, 1995 Report (Appendix F), makes no 75 ES

mention of gradation testing for soil samples collected. As described above, soil gradation results are critical to the interpretation of radium-226 soil testing data. Consideration of the long historical operation of the facility, suggests that great care should be taken in determination of background soil conditions for the facility. Consequently, NRC should require Atlas to provide gradation results with their radium-226 data for Moab Wash sandy soils that will be used in cover's filter layer. These results should be reviewed and approved by the NRC before any construction of radon barrier, in order to allow adequate disposal of these materials should they prove to contain higher than background concentrations of radium-226. **This is an open State issue.** 75 ESE

46. Radon Barrier Clay: Unjustified Design (Section 6.2.3) - Atlas has not yet identified the borrow source for the clay radon barrier material nor provided independent analysis of its unsaturated soil properties (DTER, p. 6-8). In order to facilitate the review process, NRC staff have used soil characteristic data from Mancos Shale derived soils generated by the U.S. Department of Energy (DOE) at its Title I cleanup project in Grand Junction, Colorado, some 75 miles distant from the nearest source of Mancos Shale material. 76 EST

However, no information has been provided to demonstrate why the DOE evaluation of its Mancos Shale materials was adequate. Furthermore, NRC staff have not justified how the Mancos Shale material in Grand Junction, Colorado is representative of the clay materials to be harvested locally from Klondike Flats. Nor has any evaluation been made of the diffusivity, moisture retention, and other unsaturated soil characteristics that will be produced after the native shale is reconstituted into a clay and constructed as a final engineered material over the tailings embankment.

Based on these unknowns, the ability of the proposed cover design to adequately control radon emanations from the pile is highly suspect. Consequently, this aspect of the engineering design is unjustified, and must be resolved before any NRC approval of the final engineering design or Reclamation Plan. **This is an open State issue.**

47. Inadequate Radon Flux Models (Section 6.3) - currently Atlas has committed to redo their radon flux model if confirmation testing of their "affected" soil, coarse tailings, or radon barrier clay are found to differ "significantly" from the assumed model input values. Currently, it is several critical design parameters are unknown, including: 77 ES

A. Average Radium-226 Concentrations - of upper 15 feet of the tailings pile, including tailings material, "affected" soils, radon barrier clay, and sandy soil filter materials.

B. Unsaturated Soil Characteristic Data - for the final radon barrier, including both clay and sandy materials.

C. Average, Long-Term In-Situ Moisture Content - of radon barrier soils, including sandy "affected" soils, overlying clay, and overlying sand filter materials. This

includes soil moisture conditions not only at the time of construction, but also average conditions throughout the life of the tailings pile (1,000 years).

D. Frost Penetration Uncertainty - it is still unclear if frost penetration calculations presented previously by Atlas were representative or conservative of current and possible future on-site conditions.

E. Ability of Cover Design to Resist Subsidence Related Upset - the magnitude of possible future land subsidence and an evaluation of the ability of the radon barrier to resist it has yet to be provided by Atlas or reviewed by the NRC.

Consequently, It is inappropriate to approve any engineering design for the cover materials without Atlas having first provided this information and the NRC afforded the opportunity to arrive at a satisfactory conclusion. To allow construction of the cover materials without resolution of these design issues runs the risk of late discovery of such design problems and added costs of retrofit design and construction. Therefore, the NRC should require Atlas to resolve all these issues and demonstrate adequate cover design as it relates to control of future radon flux before any approval of the cover design of the Reclamation Plan. **This is an open State issue.**

48. Uncertainty of Radon Barrier Durability (Section 6.4) - the NRC analysis presented in this section assumes the clay radon barrier will not thinned, cracked or breached by settlement of the embankment. Contrary to this, NRC geotechnical staff have concluded that insufficient information is currently available to make such a conclusion, and have required Atlas to provide piezocone test data from the tailings and engineering analysis in order to resolve this issue (DTER, p. 3-2). Consequently, the radon flux modeling conclusions referenced in Section 6.4 are premature and unjustified.

Section 6.4 of the DTER also ignores the possibility of desiccation cracking during construction of the clay radon barrier, an issue raised above by the State. If the construction quality assurance testing issues raised above are not adopted, or otherwise resolved by Atlas, then the radon flux modeling must include the effects of desiccation cracks on the clay radon barrier in any assessment of radon emanation control.

This section also fails to address changes in radon emanation in the event that differential subsidence thins or breaches the radon barrier. Until this possibility is thoroughly evaluated and resolved by Atlas, the radon emanation predictions presented in the DTER are hasty and unjustified.

All of these issues must be resolved before the existing radon flux model results cited in Section 6.4 could be considered satisfactory. **This is an open State issue.**

77 78 ES

49. Revisions Needed to NRC Appendix A Conclusions (Section 7.0) - in light of the many State concerns regarding technical conclusions reached in the DTER, as described above, it appears that many of the conclusions regarding compliance of the Atlas site with the Criterion in 10 CFR 40, Appendix A are premature, incomplete, and/or unfounded. We suggest that this section of the DTER be rewritten after completion and resolution of all the above State concerns and issues. (79) MHF

CONCLUSIONS

Review of the DTER has shown a large number of State technical concerns and open issues regarding the Atlas Reclamation Plan and facility, which have not yet been addressed by the NRC. These concerns can be grouped into 14 general categories, which are summarized below:

1. Inadequate subsurface geologic model for site.

2. Incomplete and unjustified engineering design specifications.

3. Inadequate construction quality assurance/quality control requirements.

4. Inadequate hydrogeologic characterization of both tailings pile and mill site areas.

5. Inadequate groundwater monitoring for tailings pile and mill site.

6. Need to investigate potential groundwater contamination of Arches National Park and adjoining private property.

7. Need to implement a groundwater monitoring quality assurance/quality control plan.

8. Inadequate characterization of tailings leachate characteristics.

9. Need to require groundwater monitoring for additional tailings contaminants.

10. Need to revise and justify groundwater protection standards.

11. Need to enforce NRC Criterion 5D groundwater corrective action program requirements at facility.

12. Need to investigate apparent non-radiologic contamination of the Colorado River.

13. Need to complete a performance assessment to demonstrate final engineered cover can adequately protect local groundwater and surface water resources.

14. Need to require Atlas to implement a viable groundwater corrective action program that will protect both ground and surface waters.

From material presented in the DTER, and independently by NRC staff and Atlas, it is also apparent that Atlas has not yet provided adequate characterization of geologic and hydrogeologic conditions at their facility. Critical pre-design information for many engineered materials has yet to be provided that could justify the proposed design basis for the tailings pile cover. Furthermore, Atlas has not provided adequate construction quality control measures to ensure that the tailings cover will be field constructed in compliance with any approved design.

Consequently, approval of the Reclamation Plan and any engineering design for on-site stabilization of the tailings is premature and unjustified.

As a consequence of the many and various open issues and concerns regarding the Atlas facility, the engineering design proposed by Atlas and articulated by the NRC in the January, 1996 Draft TER is incomplete and unjustified. Because of the preliminary nature of the current engineering design and the myriad of open issues present, it appears that the final design for the tailings embankment cannot be approved without prior resolution of both the NRC and State open issues.

REFERENCES

Adams, J. P., September, 1995, "National Low-Level Waste Management Program Radionuclide Report Series, Vol. 15: Uranium-238", Idaho National Engineering Laboratory in behalf of the U.S. Department of Energy, pp. 35.

Aitken, G. W. and Berg, R.L., 1968, "Digital Solution of Modified Berggren Equation to Calculate Depths of Freeze or Thaw in Multilayered Systems", U.S. Army Corp of Engineers, Cold Regions Research & Engineering Laboratory Special Report 122.

Atlas Minerals, May, 1984, "License Renewal Application, Source Material License No. SUA-917, NRC Docket No. 40-3453", NRC docket file document.

Atlas Minerals, March 8, 1996, Letter From Mr. Richard Blubaugh to Residents of Castle Valley, p. 2.

Blanchard, P. J., 1990, "Ground-Water Conditions in the Grand County Area, Utah, with Emphasis on the Mill Creek - Spanish Valley Area", a USGS study completed in cooperation with the Utah Department of Natural Resources (DNR), DNR Technical Publication No. 100.

Colorado River Basin Salinity Control Forum, February 28, 1977, "Policy for Implementation of Colorado River Salinity Standards Through the NPDES Permit Program", 4 p.

Canonie Environmental Services Corporation, March, 1995, "NRC Request for Information - November 4, 1994, Atlas Corporation Reclamation Plan, Uranium Mill and Tailings Disposal Area, Moab, Utah", consultant's report.

Cooksley Geophysics, August, 1995,"Reflection Seismic Survey of Atlas Minerals Tailing Site Three Miles Northwest of Moab, Utah", unpublished consultants report, 16 p.

Cooksley Geophysics, January 9,1996, Addendum to report entitled "Reflection Seismic Survey of Atlas Minerals Tailing Site Three Miles Northwest of Moab, Utah", unpublished consultants report, 2 p.

Dames and Moore, October 27, 1982, "Ground Water Monitoring Project Uranium Mill Tailings Impoundment Moab, Utah for Atlas Minerals", consultants report.

Doelling, H. H., Ross, M. L., Mulvey, W. E., August, 1995, "Interim Geologic Map of the Moab Quadrangle, Grand County, Utah", Utah Geological Survey Open File Report 322.

Domenico, P. A. and F. W. Schwartz, 1990,"Physical and Chemical Hydrogeology", John Wiley and Sons, New York, pp. 824.

Driscoll, F. G., 1986, "Groundwater and Wells", 2nd Ed., Johnson Division, St. Paul, Minnesota, pp. 1089.

EnecoTech. February 25, 1988. "Ground Water Hydrology Detection Monitoring Program Atlas Minerals Moab Uranium Mill Grand County, Utah", consultants report.

EnecoTech. April 28, 1988. "Technical Responses for Ground Water Detection Monitoring Program", consultants report.

Freeze, R. A., and Cherry, J. A., 1979, Groundwater, Prentice-Hall, Inc, Englewood Cliffs, New Jersey., pp. 604.

Hem, J.D., 1985, "Study and Interpretation of the Chemical Characteristics of Natural Water", USGS Water-Supply Paper 2254, 3rd Edition.

Moench, A. F., July, 1984, "Double-Porosity Models for a Fissured Groundwater Reservoir with Fractured Skin", Water Resources Research, vol. 20, no. 7, pages 831-846.

Price, D., April 18, 1959, "Memorandum Summarizing the Drilling and Test Pumping of a Replacement Well at Arches National Monument Grand County, Utah", U.S. Geological Survey, Branch of Ground Water Administrative Report.

Smith Environmental Technologies Corporation, December, 1995, "Response to NRC Comments, Atlas Corporation Reclamation Plan Uranium Mill and Tailings Disposal Area, Moab Utah", consultants report, pp. 4 with appendices.

Smith Environmental Technologies Corporation, February, 1996, "Response to NRC Open Issues, Atlas Corporation Reclamation Plan Uranium Mill and Tailings Disposal Area, Moab, Utah", consultants report, pp. 8 with tables and figures.

Soukup, A. V., September, 1978, "Report on Evaluation of Environmental Health Facilities, Arches National Park, Utah", U.S. Public Health Service/National Park Service, internal agency report.

Todd, D. K., 1980, Groundwater Hydrology, John Wiley and Sons, New York, pp. 535.

U.S. Environmental Protection Agency, September, 1986, "RCRA Ground-Water Monitoring Technical Enforcement Guidance Document", OSWER-9950.1/

U.S. Environmental Protection Agency, November, 1994, "Drinking Water Regulations and Health Advisories", Office of Water.

U.S. Geological Survey, 1988, "General Hydrogeology of the Aquifers of Mesozoic Age, Upper Colorado River Basin - Excluding the San Juan Basin - Colorado, Utah, Wyoming, and Arizona", Hydrologic Investigations Atlas, Atlas HA-698.

U.S. Nuclear Regulatory Commission, October 21, 1987 Letter from Edward F. Hawkins to Atlas Minerals Regarding NRC Sampling and Analysis of Atlas Tailings Effluent.

U.S. Nuclear Regulatory Commission. June 15. 1988 Letter from R. Dale Smith to Atlas Minerals. Transmittal of Radioactive Materials License. Amendment No. 1.

U.S. Nuclear Regulatory Commission. December 13. 1988 Memorandum from Gary R. Konwinski to Docket File No. 40-3453 Regarding Establishment of Ground-Water Protection Standards.

U.S. Nuclear Regulatory Commission. December 14. 1988 Letter from R. Dale Smith to Atlas Corporation. Transmittal of Radioactive Materials License No. 4.

U.S. Nuclear Regulatory Commission. July 18. 1989. Radioactive Materials License Amendment No. 8.

U.S. Nuclear Regulatory Commission, June 22, 1990, Radioactive Materials License Amendment No. 11, and Staff Memorandum by G. R. Konwinski of same date.

U.S. Nuclear Regulatory Commission. January 22. 1996 Letter from NRC to Richard Blubaugh. Atlas Corporation. Transmittal of Radioactive Materials License. Amendment No. 26.

Utah Climate Center (Utah State University). Internet Address: climate.usu.edu/free. weather station no. 42573307. latitude 38° 35'. longitude 109° 33' W. elevation 4,043 ft amsl.

Utah Division of Water Rights. Well Drillers Reports Nos. 3307 (March 13. 1944). 13802 (January 14. 1959). Water Rights Application/Claim No. A57272 (September 11, 1981).

Utah Geological Survey. "Review of Documents for the Atlas Corporation Uranium Mill Site in Moab, Utah". April 10. 1996 Project Review Memorandum by Francis X. Ashland, 9 pp.

Western Technologies. October 31, 1988. "Atlas Moab Mill Ground Water Detection Monitoring Program", consultants report.

Western Technologies. March. 1989. "Draft/Final Atlas/Moab Uranium Mill and Tailings Corrective Action Plan Moab. Utah", consultants report.

Woodward-Clyde. November 3, 1995,"Evaluation of Potential Seismic and Salt Dissolution Hazards at the Atlas Uranium Mill Tailings Site. Moab, Utah", draft final consultants report.

Woodward-Clyde. January 29. 1996. "Evaluation of Potential Seismic and Salt Dissolution Hazards at the Atlas Uranium Mill Tailings Site. Moab, Utah", final consultants report.

ATTACHMENT 1

Utah Geological Survey Comments
on
NRC Draft Environmental Impact Statement, Technical Evaluation Report, and Related Atlas Documents

by

Francis X. Ashland
Project Geologist

April 10, 1996

March 25, 1997

40-3453

R. Bruce Rodgers, Chief
Division of Resource Management
Canyonlands & Arches National Parks
National Park Service
2282 S. West Resource Blvd.
Moab, Utah 84532

SUBJECT: PRELIMINARY FINAL ENVIRONMENTAL IMPACT STATEMENT FOR THE ATLAS MILL SITE IN MOAB, UTAH

Dear Mr. Rodgers:

The preliminary Final Environmental Impact Statement (pFEIS) for the Atlas Moab, Utah uranium mill reclamation is being sent to you under separate cover by Oak Ridge National Laboratory. In accordance with your request, 4 copies are being sent directly to you, 3 copies are being sent to Chris Turk, and 3 to Dan Kimball. This version of the FEIS is for internal review only and should not be disseminated outside of the Department of the Interior.

We received 242 comment letters on the Draft Environmental Impact Statement (DEIS). While many of the letters either supported or opposed the licensee's proposed reclamation plan without much technical basis, significant technical concerns were identified in some letters. We have summarized and responded to all the comments in Appendix A of the pFEIS and have revised the pFEIS where necessary to address comments. However, our conclusion remains the same as in the DEIS, i.e., that the licensee's proposed reclamation plan is acceptable with respect to environmental costs and benefits.

As we discussed by telephone on March 13, 1997, we would like to meet with the National Park Service to discuss your comments and suggestions on the pFEIS. As we discussed, we propose to meet via videoconference. A videoconference would result in considerable savings in staff time and travel expenses for both our agencies and allow all appropriate technical staff to participate. We suggest holding the videoconference during the week of April 14.

I will be in contact with you to make arrangements for the videoconference. If you have any questions, please call me at (301) 415-6629.

Sincerely,
(Original signed by)
Myron Fliegel
Senior Project Manager
Uranium Recovery Branch
Division of Waste Management, NMSS

NLXP 1/0

cc: C. Turk, NPS
D. Kimball, NPS
V. Rai, DOI

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CHAIRMAN

UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555-0001

June 4, 1997

See Rpt.

The Honorable John McCain
United States Senate
Washington, D.C. 20510-0303

Dear Senator McCain:

I am responding to your letter of April 25, 1997, in which you expressed concern about a uranium mill tailings pile near the Colorado River in Moab, Utah. The mill is owned by Atlas Corporation, which holds Nuclear Regulatory Commission (NRC) license SUA-917. Your letter raises several concerns related to the vulnerability of the tailings pile to damage from Colorado River floods and the subsequent consequences to the river.

The Uranium Mill Tailings Radiation Control Act (UMTRCA) of 1978, as amended, established the framework for NRC regulatory authority over uranium mill tailings. In accordance with UMTRCA, the Environmental Protection Agency (EPA) promulgated standards for the reclamation of tailings piles, and NRC conformed its regulations to those EPA standards. The NRC requirements appear in Appendix A to 10 CFR Part 40 (Part 40). Part 40 requires that the tailings reclamation be designed to be effective in the control of radiological hazards for 1000 years. NRC standards also require that this 1000-year control be achieved without reliance on active maintenance. In the review of licensees' proposed reclamation plans and the ability of the plans to meet the 1000-year standard, NRC considers natural phenomena that may pose a threat to the tailings piles, including the potential for erosion by floods and runoff from precipitation.

In March 1997, following review of the Atlas reclamation design, the NRC staff concluded that it met the applicable standards in Part 40. The staff's conclusions on flooding and erosion are documented in its Technical Evaluation Report (Enclosure). The NRC review considered not only floods on the Colorado River, but also floods on Moab Wash, a nearby ephemeral stream, as well as the capability of the pile's drainage system to convey runoff from intense local precipitation without disturbing the tailings. The staff concluded that Colorado River floods do not present an erosion threat to the tailings because 1) there is a narrow gorge two miles downstream that restricts flow, resulting in a backup of flood waters upstream; 2) due to the backup, water will spread over a large area, particularly on the Moab side of the river, and this large flow area results in low velocities; and 3) dense vegetation near the tailings pile will keep velocities low. Floods in Moab Wash present a greater erosion threat to the tailings pile than floods from the Colorado River, and the erosion protection design addresses that threat.

LF01

Your letter also raised concerns about the effects of this year's spring flood, which is expected to be greater than normal. Presently, it is not clear if the spring flood will exceed the 1984 flood, because spring runoff depends on highly variable factors such as snowpack, temperature, and coincident rainfall amounts. However, even if the 1984 flood were exceeded, no erosion or damage to the pile is anticipated because there is a temporary

m/42

cover that will avoid tailings contact with the river, and, as stated above, floods on this reach of the Colorado River are non-erosive. It should be noted that the 1984 flood reached the toe of the tailings pile with no adverse erosion consequences.

It is possible that during a flood a small amount of the contaminated leachate in the tailings may seep into the river. The leachate contains heavy metals, uranium, and ammonia, but the amounts that could seep into the river during a flood would be insignificant given the large amount of dilution that would occur.

The NRC has worked closely with the EPA Denver office in the preparation of the Final Environmental Impact Statement. This working relationship has helped NRC understand and address all concerns raised by EPA as a result of EPA's review of the Draft Environmental Impact Statement. In addition, the NRC is waiting for the Fish and Wildlife Service (FWS) to prepare a final Biological Opinion under Section 7 of the Endangered Species Act. This is the last piece of information NRC needs to issue the Final Environmental Impact Statement. At present, FWS is scheduled to provide NRC with a draft Biological Opinion no later than mid-June 1997. Once this is received, NRC will work with FWS and Atlas, if appropriate, to develop a final Biological Opinion.

As part of its evaluation of groundwater cleanup at the site, NRC will ensure that groundwater contaminants are cleaned up to the applicable standards. Currently, near-surface groundwater between the tailings pile and the river is contaminated and some of this contamination is seeping into the Colorado River. As a result there is a small mixing zone in the Colorado River with elevated levels of some constituents, with ammonia being of greatest concern. This contamination is a remnant of mill operations from decades ago; it exists independently of whether the tailings are moved, and will slowly flush into the Colorado River. This situation is a short-term impact that should be substantially improved once reclamation, including an impermeable cover to reduce infiltration into the tailings, is complete, and the groundwater is cleaned up to appropriate standards. The State of Utah, as an EPA permitting State, is responsible for the regulation of ammonia in both the groundwater at the site and the Colorado River. NRC plans to follow closely the State of Utah review of the ammonia situation.

In summary, the NRC agrees that the Colorado River is a vital natural resource that must be protected. Toward that end, the NRC staff will ensure that the reclamation plan proposed by the Atlas Corporation provides reasonable assurance that public health and safety and the environment are protected. If I can be of further assistance, please contact me.

Sincerely,

Shirley Ann Jackson

Shirley Ann Jackson

Enclosure:
Technical Evaluation Report

JOHN McCAIN
ARIZONA

CHAIRMAN, COMMITTEE ON COMMERCE
SCIENCE, AND TRANSPORTATION
COMMITTEE ON ARMED SERVICES
COMMITTEE ON INDIAN AFFAIRS

United States Senate

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(602) 491-4300

2400 East Arizona
Biltmore Circle
Suite 1150
Phoenix, AZ 85016
(602) 952-2410

450 West Paseo Redondo
Suite 200
Tucson, AZ 85701
(520) 670-6334

Telephone for Hearing Impaired
(202) 224-7132
(602) 952-0170

April 25, 1997

Shirley Ann Jackson
Chairman
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

Dear Ms. Jackson:

I am writing because I am very concerned about a uranium tailings pile near the Colorado River in Moab, Utah. I understand that remediation proposals are currently under consideration by the Nuclear Regulatory Commission (NRC) and a final Environmental Impact Statement (EIS) will be issued soon.

According to media reports, this tailings pile is located in the river's flood plain. I further understand that the spring flows are expected to be the highest in 15 years and that some environmental groups believe the site poses a threat to the Colorado River. I ask that you work with the EPA to ensure the area is secured from the Spring flows.

I am also concerned about how to remediate the tailings pile in the long-term and want to be sure that any action comports with the Clean Water Act. Therefore, I have contacted the Environmental Protection Agency to ask that they evaluate any proposed remediation to ensure that the Colorado River is protected.

I understand that the NRC is poised to issue an EIS which does not require moving the uranium tailings pile but, instead, would cap the materials in place. I am extremely concerned that, given the proximity of these harmful materials to the Colorado River, a flood event could lead to its contamination.

Therefore, in accordance with all appropriate rules, regulations and ethical guidelines, I ask that you take all steps necessary to ensure that any long term plan for remediation of the tailings pile protects the Colorado River and that, in the interim, the Colorado River is protected against any risks that may be posed by an excessive spring flow.

The Colorado River is a vital natural resource. I am sure that you agree that we must do all we can to protect it from pollution.

Sincerely,

John McCain
United States Senator

JM/bsl

June 10, 1997

40-3453

ICF Incorporated
ATTN: Paul Bailey
9300 Lee Highway
Fairfax, VA 22031-1207

SUBJECT: REVIEW OF ATLAS CORPORATION FINANCIAL DOCUMENTS - TASK ORDER TWO

Dear Mr. Bailey:

Enclosed is the task outline for Atlas Corporation. Assistance is required to review the financial condition to ascertain whether it will continue to be a going concern in the future and whether there had been any trends of excessive remuneration or transfer of assets over the last three years.

The action taken by this letter is within the scope of the current contract J5054. By June 17, 1997: 1) provide a brief description on how you will perform the review; 2) an estimate of the cost of the effort; 3) a list of those individuals who will perform the review; and 4) an updated statement of the professional qualifications of the principal reviewers.

Sincerely,

[ORIGINAL SIGNED BY:]

Louis M. Bykoski
Facilities Decommissioning Section
Low-Level Waste and Decommissioning
Projects Branch
Office of Nuclear Material Safety
and Safeguards

Enclosure: As stated

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UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555-0001

June 10, 1997

ICF Incorporated
ATTN: Paul Bailey
9300 Lee Highway
Fairfax, VA 22031-1207

SUBJECT: REVIEW OF ATLAS CORPORATION FINANCIAL DOCUMENTS - TASK ORDER TWO

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The action taken by this letter is within the scope of the current contract J5054. By June 17, 1997: 1) provide a brief description on how you will perform the review; 2) an estimate of the cost of the effort; 3) a list of those individuals who will perform the review; and 4) an updated statement of the professional qualifications of the principal reviewers.

Sincerely,

Louis M. Bykoski
Facilities Decommissioning Section
Low-Level Waste and Decommissioning
Projects Branch
Office of Nuclear Material Safety
and Safeguards

Enclosure: As stated

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UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555-0001

July 28, 1997

40-3453

The Honorable Dianne Feinstein
United States Senate
Washington, D.C. 20510-0504

Dear Senator Feinstein:

I am responding to your letter of July 9, 1997, to Mr. Dennis K. Rathbun, in which you requested Nuclear Regulatory Commission review and consideration of several constituent letters expressing concern about a uranium mill tailings pile near the Colorado River in Moab, Utah. The mill is owned by Atlas Corporation, which holds NRC license SUA-917. NRC is currently evaluating Atlas' proposed plan to reclaim the mill site, including 10.5 million tons of tailings. Atlas' proposed plan calls for reclamation of the tailings at its present location. An alternative site, 18 miles away, has been identified and considered in the environmental review discussed below.

Over the past four years, NRC has been thoroughly reviewing the Atlas Corporation's proposal to reclaim the mill tailings at its current location. NRC's review included two evaluations of Atlas' proposed action. In one analysis, NRC conducted a detailed review of the proposal to determine if the appropriate NRC safety standards for tailings reclamation found in 10 CFR Part 40, Appendix A, would be met. In addition, NRC is preparing an environmental impact statement (EIS) to determine what environmental impacts could be expected if NRC were to find the Atlas proposal acceptable.

NRC has carefully reviewed the Atlas reclamation design and in March 1997 concluded that the proposal for on-site stabilization meets the requirements in Part 40, Appendix A. These findings are documented in NUREG-1532, "Final Technical Evaluation Report for the Proposed Revised Reclamation Plan for the Atlas Corporation Moab Mill." A copy is provided in Enclosure 1. In the draft EIS issued in January 1996, NRC found that either on-site stabilization or relocation of the tailings to the alternate site was environmentally acceptable. A copy of the draft EIS, NUREG-1531, "Draft Environmental Impact Statement Related to Reclamation of the Uranium Mill Tailings at the Atlas Site, Moab, Utah," is provided as Enclosure 2.

We expect to complete the final EIS later this year. We are waiting for the Fish and Wildlife Service (FWS) to prepare a final Biological Opinion, under Section 7 of the Endangered Species Act, which is the last piece of information NRC needs to issue the final EIS. On July 2, 1997, NRC received the draft Biological Opinion, which concluded that the Atlas proposal would likely jeopardize the continued existence of four endangered species of fish in the Colorado River. Staff is currently reviewing the technical basis of the draft Biological Opinion and will provide its comments to FWS to use in preparation of the final Biological Opinion. NRC will take no action until it completes and issues the final EIS.

The constituent letters you enclosed identified two issues: 1) a concern that drinking water from the Colorado River is being contaminated by the Atlas tailings; and 2) an appeal that the

tailings be moved to another location, even if the Federal government pays for the reclamation.

With respect to the first issue, let me assure you that Atlas' mill tailings do not present a threat to the water supply of southern California and neighboring States for the following reasons: a) the tailings pile's current contribution to the concentration of various constituents in Colorado River water represents a small fraction of the actual concentrations in the river; b) the seepage of contaminants from the tailings pile to the river is the result of operations at the mill many years ago and has been occurring for decades without apparent adverse effects on the water supply; and c) the reclamation plan proposed by Atlas will significantly reduce that seepage in the future.

Further explanations of each of the above follow:

a) Currently, near-surface groundwater between the tailings pile and the river has some contamination that is slowly seeping into the Colorado River. However, because the seepage rate is so small in comparison with the river's flow and the natural contaminants in the river, impacts on Colorado River water quality are negligible outside of a local mixing zone. Seepage from the contaminated groundwater to the Colorado River is estimated to average 1.25 cubic feet per second (cfs), whereas the average Colorado River flow at Moab is 7770 cfs, resulting a dilution factor of more than 6000. More dilution is provided downstream of Moab as tributaries, runoff, and groundwater further contribute to Colorado River flow. Because the tailings are ground-up ore, originally mined in the Colorado River basin, the heavy metals and radioactive contaminants they contribute to the river are the same as those that naturally enter the river from the surrounding terrain.

b) Current groundwater contaminant levels near the tailings pile reflect past, more severe pile conditions that resulted in higher seepage rates than at present. During mill operation, the tailings pile was completely saturated and a pool of water, with high concentrations of contaminants, existed on the top. During the past several years, the pool has evaporated and Atlas has begun to dewater the tailings. This is reducing the seepage of tailings water into the near-surface groundwater. However, because of the long groundwater travel time (we estimate that it takes about 20 years for groundwater to travel from the tailings pile to the river), current groundwater seepage into the river represents the effects of when the mill was operating. The water currently drawn from the Colorado River includes this contribution from the tailings, as it has for years. However, as discussed above, the contribution of the tailings contaminants is trivial in relation to natural levels of river constituents.

c) Atlas' proposed reclamation plan for the tailings pile includes a relatively impermeable clay cover for the tailings. This cover would restrict infiltration of water into the pile and thus significantly reduce the seepage of contaminated water from the pile to the groundwater and ultimately to the Colorado River. We estimate that seepage would be reduced by at least a factor of 6. Furthermore, under NRC regulations, Atlas will be required to remediate groundwater contamination to a level that does not pose a substantial present or potential hazard to human health or the environment. Thus, the contribution of contaminants from the Atlas tailings to the river will be substantially reduced after completion of Atlas' proposed reclamation and groundwater remediation.

The second constituent issue is that the tailings be moved to another location. As an independent regulatory agency, it is NRC's job to determine if activities proposed by licensees comply with NRC's regulations. The only options available to NRC are to either: 1) accept the proposal; 2) accept the proposal with modifications; or 3) deny the proposal. Because NRC must have a firm regulatory and technical basis to accept or deny a proposal, it cannot make either decision arbitrarily. For the specific case of the Atlas tailings, even if NRC were to deny the Atlas proposal for on-site reclamation, this does not mean that Atlas would choose to move the tailings. Rather, Atlas, as the party ultimately responsible for the site, could request a hearing on the NRC denial, or Atlas could decide to modify the denied proposal, and resubmit it to NRC. Because there is no significant health and safety issue with the Atlas proposal, NRC cannot order Atlas to take a specific approach. NRC can only evaluate the proposal made by Atlas, and determine if it complies with the applicable regulations.

Further, even if NRC concluded that the tailings must be moved, it appears that the responsible party, Atlas, does not have the financial resources to fund relocation. Other parties with responsibilities related to remediation of radiologically contaminated sites probably could not undertake relocation of the Atlas tailings under existing legislation and regulations. NRC does not have the authority to reclaim tailings sites. The U.S. Department of Energy's (DOE's) authority to clean up tailings sites is limited to specific programs such as the Uranium Mill Tailings Radiation Control Act of 1978, Title I program. The Atlas site does not qualify under any DOE program. It is unclear if the Atlas site would qualify for placement on the Superfund list, because of the relatively low hazard it represents. Even if the site were put on the list, informal discussions with Utah and the U.S. Environmental Protection Agency indicate that it would have a low priority, and it would be unlikely that the tailings would be moved.

In closing, NRC recognizes that the Colorado River is a vital natural resource that must be protected. To this end, I would like to assure you that NRC has conducted its review of the Atlas proposal in a diligent manner. The ultimate conclusions reached by NRC will be technically and environmentally sound, and consistent with the legislative authority provided NRC by Congress. If Congress decides that it wants to authorize or fund a reclamation other than the one Atlas has proposed to NRC, NRC would, of course, conduct any necessary reviews of an alternative approach. I trust that this reply responds to your request and clarifies our position. If I can be of further assistance, please contact me.

Sincerely,

L. Joseph Callan
Executive Director
for Operations

Enclosures: As stated

NUREG-1531

Draft
Environmental Impact Statement
Related to Reclamation of the Uranium Mill Tailings at the Atlas Site, Moab, Utah

Source Material License No. SUA 917
Docket No. 40-3453
Atlas Corporation

U.S. Nuclear Regulatory Commission

Office of Nuclear Material Safety and Safeguards

January 1996

NUREG-1532

Final Technical Evaluation Report for the Proposed Revised Reclamation Plan for the Atlas Corporation Moab Mill

Source Material License No. SUA 917
Docket No. 40-3453
Atlas Corporation

U.S. Nuclear Regulatory Commission

Office of Nuclear Material Safety and Safeguards

March 1997

March 13, 1998

MEMORANDUM TO: Carl J. Paperiello, Director
Office of Nuclear Material Safety
and Safeguards

FROM: Margaret V. Federline, Deputy Director [J. Holonich for]
Division of Waste Management
Office of Nuclear Material Safety
and Safeguards

40-3453

SUBJECT: SUMMARY OF TELEPHONE CONFERENCE CALL

On March 4, 1998, staff from the Office of Nuclear Material Safety and Safeguards participated in a conference call with staff from Oak Ridge National Laboratory. Attached is a summary of that conference call.

Attachment: As stated

CONTACT: M. Fliegel, NMSS/DWM
(301) 415-6629

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UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555-0001

March 13, 1998

MEMORANDUM TO: Carl J. Paperiello, Director
Office of Nuclear Material Safety
and Safeguards

FROM: Margaret V. Federline, Deputy Director
Division of Waste Management
Office of Nuclear Material Safety
and Safeguards

SUBJECT: SUMMARY OF TELEPHONE CONFERENCE CALL

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Attachment: As stated

CONTACT: M. Fliegel, NMSS/DWM
(301) 415-6629

Telephone Conference Call Summary

Date: March 4, 1998

Time: 1:30 p.m.

Participants:
Margaret Federline, Deputy Director, DWM, NMSS
Joseph Holonich, Chief, URB, DWM, NMSS
Michael Layton, URB, DWM, NMSS
Deborah Demarco, PMDA, NMSS
Myron Fliegel, URB, DWM, NMSS
Claud Pugh, Director, ORNL NRC Programs Office
Robert Reed, ORNL Project Leader for L2094
Lance McCold, ORNL NRC NEPA Program Manager
Julie Simpson, Technical Assistant to Director, ORNL NRC Programs Office
Steven Hildebrand, Director, ORNL Environmental Sciences Division

The conference call was initiated by Nuclear Regulatory Commission staff to discuss reports prepared by the Grand Junction office of Oak Ridge National Laboratory (ORNL/GJ) related to the Atlas Corporation uranium mill site near Moab, Utah. Atlas holds NRC license SUA-917 and has proposed to reclaim the mill tailings at their present location. The Tennessee office of Oak Ridge National Laboratory (ORNL/TN) has been assisting NRC in the environmental reviews related to that action and has prepared a Draft Environmental Impact Statement, a Biological Opinion (BO) related to potential impacts to endangered species, a supplement to the BO, and other environmental documentation. Recently, ORNL/GJ was tasked by NRC and the U.S. Department of Energy (acting on behalf of the U.S. Fish and Wildlife Service) to perform data collection and analysis at the Atlas site. ORNL/GJ produced three reports: "Tailings Pile Seepage Model" January 9, 1998, "Limited Groundwater Investigation" January 9, 1998, and "Supplemental Modeling and Analysis Report" February 5, 1998. NRC initiated the call to discuss ORNL management processes because of inconsistencies between analysis and conclusions in those recent ORNL/GJ reports, and analysis and conclusions documented in reports prepared by ORNL/TN.

NRC staff discussed the history of its interactions with ORNL/TN on the Atlas site and the events that lead to ORNL/GJ's involvement. NRC staff then discussed some of the significant technical conclusions in the ORNL/GJ reports that conflict with conclusions in ORNL/TN reports. The particular technical concerns were documented in a February 13, 1998 letter to the U.S. Fish and Wildlife Service. A copy of that later was previously provided to ORNL. NRC staff stated that it was not the differences in conclusions that was at issue, but rather that it appeared that ORNL/GJ had not coordinated technical findings and conclusions with ORNL/TN staff who had extensive expertise and knowledge of the Atlas site. NRC staff stressed that it was not championing a particular outcome, but rather wanted good science that was technically defendable. NRC would then use this information to help it make its regulatory decisions.

NRC staff stated that there was concern at the highest levels of NRC and that a letter to ORNL may be forthcoming. ORNL stated that it will put together a process to look at the technical differences between ORNL/GJ and ORNL/TN reports and will get back to NRC for further discussion.

August 31, 1998

Dr. William Woessner
126 McCloud Avenue
Missoula, Montana 59801

40-3453

SUBJECT: NRC-FURNISHED MATERIALS

Dear Dr. Woessner:

Enclosed please find the following materials for the U.S. Nuclear Regulatory Commission contract, "Ground-water modeling of the Atlas site."

Reports written by Oak Ridge National Laboratory, Grand Junction Colorado:

> "Limited Groundwater Investigation of the Atlas Corporation Moab Mill, Moab, Utah" January 9, 1998.
>
> "Tailings Pile Seepage Model, The Atlas Corporation Moab Mill, Moab, Utah," January 9, 1998.
>
> "Supplemental Modeling and Analysis Report, Atlas Corporation Moab Mill, Moab, Utah," February 5, 1998.

"NRC Views on Issues, Atlas Moab Mill Reclamation," transmitted to U.S. Fish and Wildlife Service by letter from Joseph J. Holonich, February 13, 1998.

"Final Technical Evaluation Report for the Proposed Revised Reclamation Plan for the Atlas Corporation Moab Mill," NUREG-1532, March 1997.

"Preliminary Final Environmental Impact Statement Related to Reclamation of the Uranium Mill Tailings at the Atlas Site, Moab, Utah," NUREG-1531, March 1997. (Predecisional)

Copies of relevant figures from "Final Reclamation Plan, Atlas Corporation, Uranium Mill and Tailings Disposal Area," Smith Technology corporation, October 1996.

A 3.5" computer disk of photographs, in electronic format, of the site and nearby areas.

If you have any questions, please contact me at (301) 415-6629.

Sincerely,

Dr. Myron H. Fliegel
Senior Projects Manager
Uranium Recovery Branch
Division of Waste Management
Office of Nuclear Material Safety
and Safeguards

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Enclosure: As stated

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November 30, 1998

MEMORANDUM TO: John W. Craig, Director
Division of Engineering Technology
Office of Nuclear Regulatory Research

FROM: John T. Greeves, Director [Signed by]
Division of Waste Management
Office of Nuclear Material Safety
and Safeguards

SUBJECT: APPRECIATION OF SUPPORT FROM RALPH E. CADY FOR HIS WORK ON THE ATLAS FINAL ENVIRONMENTAL IMPACT STATEMENT

I appreciate your cooperation in making Dr. Ralph E. Cady available to support the Division of Waste Management (DWM) in completing the Final Environmental Impact Statement (FEIS) for the Atlas mill tailings reclamation. Currently, DWM expects to issue the FEIS by the end of December. Over the past several years, the staff has been involved in a number of issues related to the Atlas proposal to reclaim 11 million tons of mill tailings in place along the banks of the Colorado River. In order to help DWM ensure the quality of the FEIS, Dr. Cady participated in an independent review of the document.

The purpose of this memorandum is to let you know that Dr. Cady's support was extremely beneficial, and was integral in helping DWM complete this highly controversial licensing action. He exhibited a keen interest in helping DWM contribute to the success of the FEIS. We appreciate the opportunity to have Dr. Cady support us, and hope that he found the experience equally beneficial.

cc: S. Bahadur, RES
R. Cady, RES
K. Carrier, PMDA (OPF)

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NAME	JHolonich		JGreeves					
DATE	11/2/98		11/20/98					

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UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555-0001

November 30, 1998

MEMORANDUM TO: John W. Craig, Director
Division of Engineering Technology
Office of Nuclear Regulatory Research

FROM: John T. Greeves, Director
Division of Waste Management
Office of Nuclear Material Safety
and Safeguards

SUBJECT: APPRECIATION OF SUPPORT FROM RALPH E. CADY FOR HIS WORK ON THE ATLAS FINAL ENVIRONMENTAL IMPACT STATEMENT

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The purpose of this memorandum is to let you know that Dr. Cady's support was extremely beneficial, and was integral in helping DWM complete this highly controversial licensing action. He exhibited a keen interest in helping DWM contribute to the success of the FEIS. We appreciate the opportunity to have Dr. Cady support us, and hope that he found the experience equally beneficial.

cc: S. Bahadur, RES
R. Cady, RES
K. Carrier, PMDA (OPF)

November 30, 1998

MEMORANDUM TO: Lawrence J. Chandler, Associate General Counsel
for Hearings, Enforcement and Administration
Office of the General Counsel

FROM: John T. Greeves, Director [Signed by]
Division of Waste Management
Office of Nuclear Material Safety
and Safeguards

SUBJECT: APPRECIATION OF SUPPORT FROM SUSAN L. UTALL FOR HER WORK ON THE ATLAS FINAL ENVIRONMENTAL IMPACT STATEMENT

I appreciate your cooperation in making Susan L. Utall available to support the Division of Waste Management (DWM) in completing the Final Environmental Impact Statement (FEIS) for the Atlas mill tailings reclamation. Currently, DWM expects to issue the FEIS by the end of December. Over the past several years, the staff has been involved in a number of issues related to the Atlas proposal to reclaim 11 million tons of mill tailings in place along the banks of the Colorado River. In order to help DWM ensure the quality of the FEIS, Ms. Utall participated in an independent review of the document.

The purpose of this memorandum is to let you know that Ms. Utall's support was extremely beneficial, and was integral in helping DWM complete this highly controversial licensing action. She exhibited a keen interest in helping DWM contribute to the success of the FEIS. We appreciate the opportunity to have Ms. Utall support us, and hope that she found the experience equally beneficial.

cc: D. Dambly, OGC
S. Utall, OGC
K. Carrier, PMDA (OPF)

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UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555-0001

November 30, 1998

MEMORANDUM TO: Lawrence J. Chandler, Associate General Counsel
for Hearings, Enforcement and Administration
Office of the General Counsel

FROM: John T. Greeves, Director
Division of Waste Management
Office of Nuclear Material Safety
and Safeguards

SUBJECT: APPRECIATION OF SUPPORT FROM SUSAN L. UTALL FOR HER WORK ON THE ATLAS FINAL ENVIRONMENTAL IMPACT STATEMENT

I appreciate your cooperation in making Susan L. Utall available to support the Division of Waste Management (DWM) in completing the Final Environmental Impact Statement (FEIS) for the Atlas mill tailings reclamation. Currently, DWM expects to issue the FEIS by the end of December. Over the past several years, the staff has been involved in a number of issues related to the Atlas proposal to reclaim 11 million tons of mill tailings in place along the banks of the Colorado River. In order to help DWM ensure the quality of the FEIS, Ms. Utall participated in an independent review of the document.

The purpose of this memorandum is to let you know that Ms. Utall's support was extremely beneficial, and was integral in helping DWM complete this highly controversial licensing action. She exhibited a keen interest in helping DWM contribute to the success of the FEIS. We appreciate the opportunity to have Ms. Utall support us, and hope that she found the experience equally beneficial.

cc: D. Dambly, OGC
S. Utall, OGC
K. Carrier, PMDA (OPF)

40-3453

Mr. David Mathes, Leader
UMTRA/Surface-Ground-Water Team
U.S. Department of Energy
19901 Germantown Road
Germantown, MD 20874

Dear Mr. Mathes:

As we discussed by telephone earlier today, the U.S. Nuclear Regulatory Commission staff needs some information with respect to claims and payments to Atlas Corporation the by U.S. Department of Energy (DOE) under Title X of the Energy Policy Act of 1994. Specifically, we need the following information:

What is the current amount of unpaid Title X claims DOE has determined are legitimate?

We understand that in the past some of Atlas' claims were disputed by DOE but that recently DOE has agreed to pay some of those claims. If so, what is the amount of previously disputed claims that DOE recently agreed to pay and what, if any, amount of Atlas' claims are still disputed by DOE? How much of any disputed claims that have been resolved will DOE pay this April?

We understand that you plan to make FY99 Title X payments in April. How much in total do you anticipate paying to Atlas?

We need the above information for a 4:00 p.m. call on March 12, 1999 and would appreciate your response by 1:00 p.m.

Sincerely,

1/0

Joseph J. Holonich, Deputy Director
Division of Waste Management
Office of Nuclear Material Safety
and Safeguards

NLXQ

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UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555-0001

March 11, 1999

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UMTRA/Surface-Ground-Water Team
U.S. Department of Energy
19901 Germantown Road
Germantown, MD 20874

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Joseph J. Holonich, Deputy Director
Division of Waste Management
Office of Nuclear Material Safety
and Safeguards

UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555-0001

SEE REPORT
40-3453

April 1, 1999

MEMORANDUM TO: N. King Stablein, Acting Chief
Uranium Recovery and Low-Level Waste Branch
Division of Waste Management

FROM: C. William Reamer, Chief
High-Level Waste and Performance
Assessment Branch
Division of Waste Management

SUBJECT: ANALYSIS OF RELEASE AND TRANSPORT OF AMMONIA FROM THE ATLAS TAILINGS PILE AND ITS FATE IN THE COLORADO RIVER

Staff from the Performance Assessment and Integration Section have developed an analysis of the ammonia releases from the Atlas Corporation tailings pile near Moab, Utah. This analysis considers the likely rate of release of ammonia from the pile, its transport to the Colorado River in the groundwater, and its concentration and flux in the river.

The analysis concludes that there would be considerable uptake of groundwater, along with its dissolved ammonia and other constituents, by a large stand of the phreatophyte Tamarix. When this uptake of ammonia by the Tamarix is taken into account, there is good agreement between estimated release of ammonia from the pile, release from the groundwater to the river, and flux in the river. This result gives high confidence to infiltration estimates of about 50 gallons per minute on the site during the operational period. This estimate translates to a belief that a low-permeability cover would effectively limit future infiltration and mobilization of ammonia, thereby reducing concentrations in the river.

The analysis also concludes that there would be a significant effect from bank storage, whereby during flood stage, the river would reverse the hydraulic gradient in the groundwater system and allow increased release rates of ammonia from the ground water once the river stage has dropped. This phenomenon could lead to increases in peak concentration in the mixing zone above the steady state values by up to a factor of 10 for peak concentration and 5 at the downstream extent of the allowed mixing zone.

The staff's best estimate is that the site would eventually meet the regulatory limits for acute and chronic concentrations of ammonia in the river if a 10^{-8}cm/sec cover were imposed on the tailings pile. The staff's best estimates of peak ammonia concentration in the river are 0.27 mg/L within the mixing zone and 0.125 mg/L at the downstream extent of the mixing zone. These estimates are well within the acute and chronic standards for ammonia of 1.93 and 0.38 mg/L, respectively, specified by the U.S. Fish and Wildlife Service.

CONTACT: Richard Codell, NMSS/DWM/PAHL
415-8167

Although these estimates were based on incomplete data and simplified models, the staff is reasonably confident that the site will comply under the stated conditions of a low-permeability cover. Furthermore, the staff estimates that the episodes of highest ammonia concentrations in the river will be infrequent. If the standard could be posed in terms of the frequency (e.g., the standards are met greater than 95% of the time), then the confidence in compliance would be greater.

The attached report presents the bases of the analyses and lists additional data and calculational needs to better affirm its conclusions. The report was prepared by Richard Codell, a member of my staff in the Performance Assessment and Integration Section. Ralph Cady from the Office of Research served as a peer reviewer for the calculations. Please address any questions to Richard Codell at 415-8167.

Attachment: As stated

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DATE	2/26/99	3/2/99	2/ /99	2/ /99	

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MEMORANDUM TO: King Stablein, Acting Chief
Uranium Recovery Branch
Division of Waste Management

FROM: Michael J. Bell, Acting Chief
Performance Assessment and High-Level Waste Branch
Division of Waste Management

SUBJECT: ANALYSIS OF RELEASE AND TRANSPORT FROM THE ATLAS TAILINGS PILE AND ITS FATE IN THE COLORADO RIVER

Staff from the Performance Assessment and High-Level Waste Integration Branch have developed an analysis of the ammonia releases from the Atlas Corporation tailings pile near Moab, Utah. This analysis considers the likely rate of release of ammonia from the pile, its transport to the Colorado River in the groundwater, and its concentration and flux in the river.

The analysis concludes that there would be considerable uptake of groundwater, along with its dissolved ammonia and other constituents, by a large stand of the phreatophyte Tamarix. When this uptake of ammonia by the Tamarix is taken into account, there is good agreement between estimated release of ammonia from the pile, release from the groundwater to the river, and flux in the river. This result gives high confidence to infiltration estimates of about 50 gallons per minute on the site during the operational period. This estimate translates to a belief that a low-permeability cover would effectively limit future infiltration and mobilization of ammonia, thereby reducing concentrations in the river.

The analysis also concludes that there would be a significant effect from bank storage, whereby during flood stage, the river would reverse the hydraulic gradient in the groundwater system and allow increased release rates of ammonia once the river stage has dropped. This phenomenon could lead to increases in peak concentration above the steady state values by up to a factor of 10 for peak concentration and 5 at the downstream extent of the allowed mixing zone.

The staff's best estimate is that the site would eventually meet the regulatory limits for acute and chronic concentrations of ammonia in the river if a 10^{-8}cm/sec cover were imposed on the tailings pile. However, these estimates were made on the basis of incomplete data and are therefore uncertain.

The attached report presents the bases of the analyses and lists additional data and calculation needs to better affirm its conclusions. The report was prepared by Richard Codell, a member of my staff in the Performance Assessment and Integration Section. Ralph Cady from the Office of Research served as a peer reviewer for the calculations. Please address any questions to Richard Codell at 415-8167.

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Analysis of Release and Transport of Ammonia from the Atlas Tailings pile and its Fate in the Colorado River

by Richard Codell

1. Introduction

The tailings pile at the Atlas site near Moab Utah releases ammonia and other pollutants to the Colorado River through the groundwater pathway. Current releases may exceed standards for the protection of fish and fish larvae in the river. This report addresses whether a tight clay cover on the pile would reduce releases of ammonia from the pile, and lead to concentrations in the river that comply with current standards.

The tasks involved with evaluating the effectiveness of the remediation are listed below:

- Estimate the rates of ammonia being released from the site presently and during site operation. Also estimate the release rate of ammonia into the river from discharging groundwater, and the discharge rate of ammonia in the river itself. Account for possible mechanisms for ammonia release other than discharge to the river.
- Use the estimated ammonia fluxes to back-calculate the likely fluxes of water through the tailings pile, and the effectiveness of the low-permeability cap.
- Estimate the concentrations likely to occur in the river under present-day and remediated conditions in the future.

2. Estimating Ammonia Fluxes

Estimation of the release of ammonia from the site during the active operation of the pile and the rate of water infiltrating the site is important to estimate the effectiveness of the remediation. The ammonia fluxes from the pile, through the groundwater, and into the river were calculated from observed data and proved to be consistent. The three approaches for estimating the ammonia fluxes are:

- Calculate the flux of ammonia emanating from the pile as the product of the infiltration or drainage flux of water, the sampled ammonia concentration at wells in or near the pile, and the top surface area of the pile.
- Calculate the groundwater flux from the surface aquifer into the river by integrating the product of the flux measured at sampling points close to the bank and the calculated groundwater flow rate.

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- Calculate the flux of ammonia *in* the Colorado River by integrating the product of the calculated surface water flow rate and measured ammonia concentrations in the river at one cross-section.

2.1 Estimation of flux of ammonia in water emanating from pile

It is assumed that the rate of fall of the measured water level in the pile is indicative of the seepage rate when there was standing water on the pile. The pond surface area is 3,868,102 ft^2. The average concentrations in pumping wells PW2 and PW6 is 3205 mg/l for ammonia. Assuming that the initial drainage from the pile is related to the drop in piezometer level lead to an estimate of approximately 50 gallons per minute (NRC study cited in CNWRA report, 1998). The estimated flux of ammonia leaving the pile is therefore approximately 0.9×10^6 grams/day. The groundwater travel time from the pile to the river is on the order of 10 years. Therefore, releases at the river today are probably the direct result of releases from the pile when it had standing water on top. This flux of ammonia from the pile has diminished as the pile dewatered by natural drainage and forced pumping, but the lower release has not yet reached the river.

2.2 Flux of ammonia estimated from groundwater seepage into river

The ORNL/CG (ORNL, Jan 8, 1998) estimated the flux of ammonia of 150,000 grams/day at the river bank from sampled ammonia concentrations in the piezometers, an assumed hydraulic gradient of 0.004, a measured hydraulic conductivity of 22 ft/day and an assumed aquifer thickness of 40 ft. Staff repeated the calculations, but used estimates of the hydraulic gradient at many points taken between individual piezometer, and estimated a flux of ammonia of 236,000 grams/day. The manual calculations of the ammonia flux are summarized in Table 1.

Measurement points in the water table on the flood plain indicate higher concentrations in the center than on either the upgradient or downgradient ends. One interpretation is that this represents a region of high flux that is propagating through the aquifer, and will discharge sometime later. A more likely explanation is that the water table is fluctuating from large changes in the river's stage, and that the fluctuation in concentration reflects the cyclical nature of transport in the aquifer (see discussion on bank flow transients).

2.2.1 Effect of Tamarix on water balance and ammonia flux.

There is a dense stand of Tamarix (a.k.a. saltcedar) on the banks of the Colorado River. The depth of the grove between the edge of the pile and the Colorado River is a minimum of about 800 ft and is as great as 3500 ft. Tamarix is a phreatophyte, and is known to transpire large quantities of groundwater. Phreatophytes usually take their water directly from the water table instead of the unsaturated soil zone (McWhorter, 1977). Estimates of Tamarix transpiration range from 1.4 to 10.5 ft/yr (Weisenborn, 1996). A study by the U.S. Bureau

of Reclamation at Bernardo New Mexico, about 60 miles south of Albuquerque on the banks on the Rio Grande River, may be used as an analog to conditions existing at the Atlas site (Gay and Fritschen, 1979) The New Mexico site is further south than Atlas, but is at higher elevation. It has a thick stand of Tamarix up to approximately 15 ft tall. Detailed measurements and energy budget calculations undertaken in a 5-day field trial under warm, mostly dry and cloudless conditions led to an annularized rate of transpiration of about 9.6 ft/year. However, the projected annual average transpiration for the site was estimated to be about 4.3 ft/year.

The effects of Tamarix on the water balance are likely to be significant. As an example of this hypothesis, consider a location near the river and that has the steepest gradient, for which Tamarix is likely to have the least impact. The trace length of the Tamarix grove is about 800 ft. The water table gradient would be about 5.7 ft/800 ft. The estimated hydraulic conductivity from a pump test in the aquifer is 22 ft/day (ORNL, 1998), and the aquifer thickness is estimated to be 40 ft (ORNL, 1998). The groundwater flow into the river at this point without any effect from Tamarix is calculated by Darcy's law to be:

$$q = kiH = 22ft/day \times \frac{5.7ft}{800ft} \times 40ft = 6.27ft^3/(day\ ft)$$

The annual consumption by Tamarix in the same reach, using the Bernardo NM data would be:

$$q_t = 4.3ft/yr \times 800ft \times year/365\ days = 9.3\ ft^3/(day\ ft)$$

These estimates reflect the part of the system least affected by Tamarix. Where the distance to the river is greater and the gradient smaller, the effect of Tamarix would be greater. It is likely therefore, that the Tamarix is having a significant effect on the flux of groundwater from the site and the flux of the dissolved pollutants reaching the river. Ammonia taken up by the roots of the Tamarix would either be metabolized by the plant or at least released to the atmosphere. Tamarix are well known for their ability to take up water with high dissolved minerals, and there is no reason to believe that ammonia or ammonium ion would be excluded from this uptake (Smith, 1999).

Despite these apparently large amounts of water being transpired, there are still significant releases of ammonia to the river. The main conclusion from the above analysis is that the flux of water and ammonia leaving the pile is larger than estimated entering the river, and the measured constituents at the river represent that which escape the Tamarix roots. Other factors in this analysis are:

- The transpiration of the Tamarix would be seasonal, and the larger releases of contaminants to the river may coincide with periods of low transpiration. In fact, the water table fluctuations might be daily, and fluxes into the river could depend on the

time of day. See for example, Figure 1 taken from McWhorter (1977). This could be a factor in measurements of concentrations in the river itself.

- There may be hydraulic short-circuits through the shallow aquifer, such as lenses of coarse alluvium, which could allow contaminants to bypass the effects of the Tamarix.

Observations at the site indicated that the Tamarix may be effective at removing contaminants in the plume emanating from the pile. In the central part of the plume where concentrations are highest, the vegetation is being stressed, as evidenced by its off-color appearance and thinner density. Alternative explanations for this plant stress could be fires and surface dumping, however.

2.3 Flux of ammonia in the Colorado River

Atlas contracted with Harding Lawson Associates (HLA) Inc to monitor contaminants in the Colorado River near the site (HLA, 1998). It was possible to estimate the flux of ammonia in one of the river cross-sections by integrating the product of the river flow rate and concentration in the area covered by the sampling stations. Necessary parameters of this analysis include river flow rate and stage, cross-section of the river, variations of river velocity with location in the cross section, and location of the water samples. River flow rate was recorded at the time samples were taken, but the exact location of the samples was not indicated in the HLA report. Furthermore, river velocities were not measured at the sample locations. The cross-section of the river was a rough estimate based on large-scale maps aimed mainly at flood studies, and not detailed enough for the current task (Mussetter, 1994). Depths at 10, 25 and 50 ft from the near bank were recorded at a few downstream locations in conjunction with the river sampling studies. River stage above the thalweg (lowest point in the river channel) and water velocity were also taken from Mussetter.

The cross-section selected, 3-3a, is not the most downstream reach of the affected part of the river, and therefore does not account for the total amount of ammonia reaching the river. However, most of the release is predicted to occur prior to this location.

The flow rate and velocity of water in the river within 50 ft of the shore were estimated from the following procedure:

- Represent the river cross-section by M points with M-1 straight-line segments. Therefore, the river is represented by M-1 trapezoidal segments.

- Estimate the relative flow in each of the trapezoidal river segments using assumptions of steady open-channel flow and uniform friction factors (Manning's n coefficient) across the river. This can be expressed by (Codell, et al, 1982):

$$q_j = Q \frac{\sum_{i=1}^{j} \overline{z_i^{5/3}} (\Delta y)_i}{\sum_{i=1}^{M-1} \overline{z_i^{5/3}} (\Delta y)_i}$$

where z_i = the average depth in trapezoidal river segment i, Δy_i = the distance between two points making up the line segment, q_j is the cumulative flow at the end of segment j, and Q is the total discharge in the river.

- Calculate the ammonia flux in each river segment as the product of the average water flux and average concentration in the segment.

- Sum the ammonia flux of all river segments to get the total ammonia flux in the river.

The calculation of the river flux at station 3-3a is shown in Table 2. For the stated conditions, the average flux of ammonia in the river at the station is about 263,000 grams/day. This table does not include any concentrations beyond 50 ft from the shore or downstream from cross-section 3-3a, although we believe that most of the ammonia has been accounted for at that cross-section in the river.

3. <u>Dilution in Colorado River</u>

There have been several field studies of dilution in the Colorado River to measure the concentrations of pollutants seeping from Atlas. The State's measurements have been taken only as "grab" samples at the near and far shore of the river (Utah, 1996 and Utah, 1997), whereas the Licensee's measurements have looked at multiple stations from the shoreline to 50 ft offshore, and at multiple depths (HLA, 1998). The field studies often disagree by large measures, with the Licensee's values being of generally lower concentration where they could be compared, i.e., at the shoreline. It is not clear why there is this discrepancy, but a few of the possibilities are:

- The samples were not collected at the same locations. The State claims only that their samples were "grab" samples taken at the shoreline. If the samples were very close to a seep into the river, then concentrations could vary markedly in only a few feet from the bank. Also, the locations along the bank could have been different.

- The river stage during the sampling was different.

- There could be experimental error in the measurements.

- The releases from the bank are transient, caused by bank storage.

Integration of river concentrations from the Licensee's samples was generally consistent with expected discharges of ammonia to the river from the groundwater pathway. No such comparison could be made with the State's river data because they were collected only at the shoreline. However, projecting the State's concentration data by a direct scaling of the HLA measurements, and then applying this result to a mass balance of ammonia in the river would have predicted a much larger ammonia flux in the river than could be accounted for by release from the pile or groundwater flux. For this reason, we do not believe that the State's data on ammonia in the river represent steady state fluxes.

3.1 Effect of river stage on dilution and extent of mixing zone.

Most of the sampling programs of concentration in the Colorado River were conducted at flow rates at about average river stage. Concentration and mixing zone limits however appear to apply at any time. Factors that control concentration in the river include release rate of ammonia from the groundwater to the surface water, the location of the release and the flow rate in the river. The phenomena of mixing of the contaminant plume in the river as a function of river stage are complex, and have not been explored fully for this case because of the lack of time and site-specific data. The problem is further complicated by the transient interaction of groundwater, river water, and the contaminants resulting from changes in the river stage.

3.1.1 River flow rate

The record low flow rate for the period of record on the Colorado River at the nearest upstream gage near Cisco, Utah was 558 CFS in 1934. However, the river has been regulated by upstream dams since the early 1950's, and it is not likely that such a low flow would occur again. There has been significant regulation by the Blue Mesa Reservoir since 1965. A cumulative distribution function (CDF) of flow rate at the Cisco gage since Jan. 1, 1965 is shown in Figure 2. The lowest daily flow since January 1965 has been 1100 CFS. The mean and median daily flows in that period have been 7283 and 4500 CFS, respectively. The 10th percentile low flow (i.e., 90 percent of the daily flows are greater) was 2550 CFS.

3.1.2 Dilution in River under conditions of steady groundwater release

For hypothetical steady releases of pollutants, concentrations and the extent of the mixing zone in the river will be negatively correlated (but not directly proportional) to river flow rate. The relationship between concentration in the river and flow rate is not simple. The staff did not attempt a complete model of dispersion in the Colorado River because it would have required too much time, and adequate data were lacking. However, the staff estimates empirically, based on general considerations of mixing in open-channel flow, the likely effect of dilution in the river, and estimates how changes in river flow rate will affect the concentration of ammonia. The following factors went into the estimation of the effect of flow rate on the peak concentration and the extent of the mixing zone:

3.1.3 Effect of flow on peak concentration

Regulations call for the compliance in the river with a maximum concentration anywhere of less than 1,92 mg/L ammonia. This concentration will be determined by the depth of the river, the velocity in the river, and the points or areas of entry of the contaminant groundwater plume. As river flow decreases, the velocity in the river and the stage will also decrease. Decreased stage leads to a decrease in the river width.

It is assumed that a representative low flow in the river at the site could be chosen as the 10th percentile daily low measured at the Cisco gage (it will be shown later in section 3.2 that it is not necessary to pick a single low flow for determining peak concentration). The 10th percentile daily low flow would be approximately 2550 CFS, about 48% of the reference flow rate during the HLA sampling period (HLA, 1998) of 5275 CFS. At this flow rate, the river stage is predicted by the flow-stage hydrograph, Figure 3 (derived later in Section 3.2.1) to decrease about 1.9 feet from the reference level. However average velocity decreases from 1.64 to 1.24 ft/sec, a drop of only 24% from the reference level average velocity. At lower flow rates, turbulence will decrease, leading to a diminished rate of longitudinal and horizontal mixing in the river. However, the travel time to reach a fixed downstream point will increase, partially compensating for lower turbulence.

The entry of the groundwater seepage into the river will also change at lower flow. The location of the seepage will shift as the water level drops, as shown in Figure 4. It is assumed here that river stage and water table height are equal at the bank. This should be true most of the time. However, during periods when the river stage falls quickly, there may be seepage from the bank above the river's edge and overland flow to the river. The consequences from this seepage should not be greater than the case treated because such seepage would consist mostly of river water uncontaminated with ammonia. If we assume that the rate of groundwater flow is constant and that the river is the local sink for all groundwater flow, then the streamlines of groundwater will become compressed; i.e., the same amount of groundwater will be forced into a smaller vertical distance of aquifer. If the bank of the river is of constant slope, the groundwater plume will be smaller, leading to a higher flux density of ammonia where it enters the river. If the slope of the river bank decreases as one moves from the shoreline to the center, this will tend to spread out the groundwater streamlines, compensating for this compression effect. The river bank near the site however appears to be of reasonably constant slope up to about 50 feet out, so the latter effect (spreading of streamlines) is probably less important than the former (compression of streamlines).

In summary, lowering the river flow rate will cause the plume eventually to translate horizontally to a new fixed position. Groundwater discharge will be compressed vertically, tending to increase the flux density of ammonia entering the river, leading to higher concentration of ammonia in the river. The lower flow rate and velocity will also tend to increase the peak concentration close to the bank because of reduced turbulence. River velocity will decrease modestly, leading to somewhat lower horizontal spreading and

dilution. Combining the various factors of (somewhat) smaller river velocity and compressed groundwater streamlines, the increase in maximum concentration in the river at low flow should be less than a factor of two increase in peak river concentration over the reference condition.

3.1.4 Effect of lower flow rate on longitudinal extent of mixing zone

The downstream limit of the mixing zone, described by the concentration which exceeds the chronic regulatory limit of 0.38 mg/L, is more difficult to predict. It is somewhat easier to project the change in the concentration of fixed locations. Taking the present limit of the mixing zone as that fixed location is reasonable, as it already exceeds the length of the mandated mixing zone in some cases. Using the logic of the previous section on maximum concentration, the concentration should increase by less than a factor of two at the current extent of the downstream mixing zone.

3.2 Transient flow in the Colorado River

The Colorado River is subject to large fluctuations in flow and stage, especially because of runoff from the spring melt. Water stage along the bank can vary well over 10 feet during the large annual flood. Fluctuations in the river stage near the site have the following effects on the groundwater flow from the pile to the river:

- The water level in the water table aquifer will be affected significantly by the river level.

- During periods of high river stage, flow will reverse, going into the aquifer and bringing with it water uncontaminated with ammonia. The uncontaminated river water will act to back up the natural groundwater flow. Mixing between uncontaminated and contaminated water inside the bank will be modest.

- The peak in groundwater discharge of contaminated water following high stage may coincide at times with low river stage, leading to high concentrations in the river.

- Floods that significantly overflow the bank, allowing recharge of the water table from the surface, may cause a still greater effect of flushing of the aquifer.

The effect of fluctuations in the river level was explored by coupling a one-dimensional model of transient groundwater flow to a model of surface water flow in the river. River flow rates were taken from the record at the upstream Cisco Utah gage from 1965 to the present. A schematic depiction of the coupled system is shown in Figure 5.

The groundwater model assumes one-dimensional flow from upland, with a variable phreatic surface. The downstream boundary sets the head at the first node of the model equal to the river level as a function of time. The upland boundary condition assumes no flow

(reflective), and is 1000 ft away from the river. These boundary conditions were chosen to eliminate the flow of groundwater in the aquifer model under base-flow conditions (including any effects of transpiration from shoreline vegetation), and focus only on the changes in the fluxes of water resulting from changes in the water level. Calculations of contaminant transport, shown later in Section.3.2.4, add in the base flow velocity of the groundwater calculated from the observed hydraulic gradient.

3.2.1 Model of River Stage

The water flow in the Colorado River was related to river stage within the normal banks near the site by a conveyance model based on channel cross-section and roughness (Chow, 1959). Water level in the channel was calibrated from observed stage versus flow data and also projections from flood-routing studies (Mussetter, 1994). Channel cross-sections are approximate, and account for river stage only at the location approximately corresponding to location 3-3a from the Atlas field measurements (HLA, 1998). The cross-section used in this study is depicted in Figure 6.

For steady uniform flow, the flow rate Q is related to river stage by the Manning formula (Chow, 1959):

$$Q = K\sqrt{S}$$

where S is the hydraulic gradient in the direction of flow, and K is the "conveyance":

$$K = \frac{1.49}{n} A R^{2/3}$$

The term n is the Chezy roughness coefficient, and R is the hydraulic radius of the river channel, taken as the cross-sectional area A divided by the wetted perimeter (i.e., the distance along the river bottom of the cross-section and the water surface).

It is not necessary to know the values of n or S for the purpose of generating the stage versus river flow rate as long as we assume that the values of these two variables are constant over the river reach of interest. Knowing the river stage at a particular flow rate Q_0, the river stage at a different flow rates can be estimated implicitly from the following relationship:

$$Q = Q_0 \frac{K}{K_0} = Q_0 \frac{A R^{2/3}}{A_0 R_0^{2/3}}$$

Figure 3 shows the relationship between river flow rate and stage at the 3-3a cross-section for average to low-flow conditions. Zero stage on this figure is relative to the stage at the time of the HLA sampling (HLA, 1998) corresponding to 5275 CFS. The conveyance figure for all river flows includes estimates of stage from the flood-routing study conducted by

Mussetter (1994), and is depicted in Figure 7.

The present analysis uses only the discharge at the Cisco gage, and does not account for any base flow in the approximately 31 miles between that gage and the site. Furthermore, the flood flows do not account for storm flows that might occur in sub-basins downstream of the Cisco gage, and therefore may underestimate the magnitude of some severe floods.

3.3.2 Groundwater Flow Model

Groundwater flow was calculated by assuming one-dimensional flow from upland to the river along a fixed 1000-ft length, which is the approximate distance between the river and the down-gradient end of the pile at average river stage. The present calculation does not include the natural gradient toward the river or transpiration from the Tamarix because its intent was to examine only the influence of transient river stage on flow and transport in the aquifer. For the purpose of estimating contaminant transport, the gradient-driven groundwater flow was added into the transient calculations by linearly summing the transient and steady state groundwater velocities. There is no provision in the present model for varying the length of the groundwater pathway in response to changing river stage.

The groundwater system was treated as unconfined flow with a phreatic surface, expressed by the equation:

$$\frac{\partial h}{\partial t} = \frac{k}{S_y}\frac{\partial}{\partial x}\left(h\frac{\partial h}{\partial x}\right)$$

where h = head above the reference river level, k = hydraulic conductivity, x = linear distance from shore, t = time, and S_y = storativity. This equation is nonlinear, and was solved numerically using the finite difference method with a backward-in-time implicit method. The 1000 ft interval was broken into 100 equal grid cells. Boundary conditions were fixed head at the river end and no-flow at the upland end. Hydraulic conductivity k was taken from the pump-test value in the alluvial aquifer of 22 ft/day. The storativity S_y was taken as 0.3. Most of the flow is probably occurring in the coarse gravel and sand, but this layer is overlain by a finer alluvial layer with greater quantities of silt and clay. The phreatic surface may extend into this overlying layer, which will affect the way the system responds hydraulically, and the way the contaminants will be transported.

Figure 8 is the measured response in piezometer ATP-2-S, which is located approximately 800 ft from the river, and the corresponding river level at times between 1/14/89 and 3/1/94. Figure 9 is the simulated response in the aquifer at two locations, 500 and 1000 ft from shore and the simulated river stage in response to the flow at the Cisco gage. The simulated piezometer levels are plotted as if the river datum and aquifer datum were at the same level, but since the land slopes approximately 4 ft/1000 ft, the 500 ft and 1000 ft curves should be shifted up 2 and 4 ft, respectively. When this is taken into account, the agreement of the model and prototype is quite good. This comparison lends credibility to the hydraulic model

of the groundwater/surface water system.

Figure 10 shows the net recharge and discharge of the aquifer at the bank in response to the water level fluctuations over an arbitrarily chosen 1000 day period. This figure shows large fluctuations of up to 40 cubic feet per day per ft of river bank. The corresponding base flow under natural gradient conditions at the closest distance between the pile and the river would be about 3.5 cubic feet per day per foot of bank width. If the model and parameters are correct, then there are periods when bank storage far exceeds natural seepage from the aquifer. Some anecdotal information on the likelihood of this large outflow is contained in a memorandum from the William Sinclair to Don Ostler (State of Utah, May 3, 1995). The letter speaks of an area of seepage on the river bank, discovered by the National Park Service and others in early April, 1995, immediately below the Atlas tailings embankment. The seeps spanned 50 to 200 yards and were about 2 feet above the river's level on April 5, 1995. Estimated flow in the seeps was on the order of 10 gallons per minute.

3.2.3 Effect of fluctuating river level on ammonia concentration in river

The rate of groundwater flow from and to the banks are related, but not directly proportional, to the flow rate of water to the river. During high stage, the river recharges the banks with uncontaminated water. There would be some mixing of contaminated and uncontaminated water in the aquifer. As a first approximation, the river water and groundwater can be considered to be moving in "piston" flow, simply displacing one another, but the effects of mixing or dispersion are also treated.

The largest phenomenon affecting the release and concentration in the river is likely to be that the infusion of river water to the bank will reverse the groundwater gradient, thereby stopping the release of contaminated groundwater. When this is happening, the releases of contaminants from the pile will be unrelenting, and simply be stored in the building hydraulic mound in the bank. When the river recedes, the flow again reverses, but with increased driving force and inventory of contaminated water, thereby increasing the release of contaminants to the river as a pulse. The length of these fluctuations in water level is variable, but the biggest fluctuations, associated with spring runoff floods, can persist more than one hundred days.

3.2.4 Ammonia groundwater transport model

In order to simulate the likely increases in river concentration resulting from the pulses of groundwater discharge from the bank, the groundwater flow model was enhanced to include the transport of tracer particles from the pile to the river. The particles released from the upland end of the model represent only those particles that would normally reach the river, and not those that would be taken up by transpiration of the Tamarix. The tracer particles were released, one per computational time step, at the upland end of the groundwater model, 1000 ft from the river. The particles move toward the river under the influence of the calculated steady state gradient at about 0.3 ft/day, but this must be added to the velocity

calculated in the groundwater resulting from the transient water level fluctuations. The effective porosity in the aquifer was taken to be the same as the storativity of 0.3. Particles moved at the velocity of the groundwater, and left the system permanently when they passed a boundary taken as 5 ft from the river end of the model. The effect of longitudinal dispersion was taken into account by the "random walk"[1] method, where the position of the particles can move a random distance upgradient or downgradient after each time step:

$$x' = x + v\,\Delta t + \sqrt{|v|\Delta t\,\alpha} \times N$$

where x is the initial position, x' is the position after the time step, v is the advective velocity, α is the dispersivity, and N is a normally distributed random number with mean zero and standard deviation 1.0.

The concentration in the river is taken as the rate of release of tracer particles divided by the river flow at the time of particle release. The rate of release of particles to the river is out of phase with river flow rate, because the release is delayed from the bank. This can lead to situations of large bank release and low river flow, i.e., high concentration.

Because there are a limited number of particles released, peak concentration may be exaggerated if too few particles are used to represent the continuum of dissolved ammonia concentration. Furthermore, longitudinal hydrodynamic dispersion in the aquifer may be important in smoothing out the higher peaks. The effect of dispersion on C_f in the river is shown in Figure 11 for $\alpha = 0$ and 1 ft. Including dispersion drops the highest peak levels dramatically. Figure 12 shows the concentration, in terms of particles per 10 ft grid cell, at the end of the 37 year calculation. The calculation without dispersion is evidenced by its large spikes in concentration. Adding dispersion to the model reduces these spikes significantly. Although the number of well points is limited, such large spikes characterized by the zero-dispersion case do not appear to be evident in the data, leading to the conclusion that dispersion is occurring in the aquifer.

It is useful at this point to define a "concentration factor" C_f as the concentration predicted by the model divided by the benchmark concentration representative of conditions measured in the Atlas sampling program (HLA, 1998), for which the average river flow was 5275 CFS. For example, under steady state conditions with a time step of 1/10 day the benchmark concentration would be 10 particles per day divided by a flow of 5275 CFS.

Table 3 shows the peak concentration factors and their quantiles for two different particle densities (5 per day and 10 per day), and three different longitudinal dispersivities (0, 1 and 10 ft). Also shown in this table are the results of robust smoothing (SUPSMU, MathSoft, 1993) of the particle concentrations. The smoothing calculations are an attempt to remove

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[1]This method relies on the fact that the normal probability distribution function is a solution to Fick's law of diffusion.

computational "noise" from the calculations which is an artifact of the calculation using too sparse a number of particles. The highest peak concentration factor of about 80 was predicted for 5 particles/day, no dispersion and no smoothing. Increasing the number of particles to 10 per day increased the resolution and lowered the peak concentrations to about 50 times the nominal steady state concentration. Dispersion added to the calculations leads to a significant drop in peak C_f to about 18 and 15 for $\alpha = 1$ and 10 ft, respectively. As shown in Figure 13, applying robust smoothing to the result for $\alpha = 1$ ft with a 2 day or 5 day window reduced the peak concentrations to about 14 and 13, respectively.

Other, more qualitative arguments lead to a reduction in C_f:

- The current one-dimensional model might overestimate the peak release of ammonia because it would predict release at every point along the bank simultaneously. The length of the groundwater pathway varies from a minimum of about 1000 ft to over 3000 ft. At the least, the release of contaminated groundwater from the bank would be on different schedules, depending on the length of the flow path, so the net contribution of ammonia flux to the river would have a broader, lower amplitude peak than if the contributions all happened in synchronization.

- Retardation and matrix diffusion might lead to higher mixing of contaminated and uncontaminated water within the aquifer. There may be storage mechanisms in the aquifer that lead to mixing between the contaminated and uncontaminated waters. For example, ammonia may be sorbed to an extent on the alluvium, or diffuse into the matrix of the particles. Another possible mechanism would be the forcing of contaminated water into the lower-permeability layer above the aquifer. If the phreatic surface extends into this layer, then contaminated water might be held for a longer time than would be suggested by the properties of the coarse alluvial aquifer alone.

- The calculations performed assume that the concentration in the river is inversely proportional to the river flow rate. However the arguments made in section 3.1 about concentration effects at low river flow lead to a position that halving the flow rate of the river results in less than a doubling of concentration and extent of the mixing zone; i.e., C is proportional to Q^p where p is a number less than 1. The effect of river flow rate on concentrations is therefore overestimated.

- The highest concentrations in the river would occur infrequently. Figure 14 shows the cumulative distribution function of C_f for $\alpha = 1$ ft. The peak C_f would be 18.5, but the 99th percentile results would be only 7.75. If something less than absolute highest concentration factor at any time is acceptable, the case could be made that the concentration would be considerably smaller than the peak. Note that this is a "frequency" argument rather than an "uncertainty" argument. Uncertain relates to the degree of belief in our model.

On the basis of the modeling results and the qualitative arguments, it is reasonable to predict that concentrations in the river might by amplified by a factor of 10 above nominal steady state concentrations as a result of variable river flow and bank storage.

3.2.5 Calculation of Peak and Chronic Concentrations

The highest measured shoreline concentration from the HLA study was 2.4 mg/L ammonia (HLA, 1998). Taking credit for a 10^{-8} cm/sec cover on the tailings pile would offer a reduction in concentration by a factor of 0.0114. Combining this with the C_f estimate of 10 would yield a concentration under remediated conditions of 2.4 x 0.0114 x 10 = 0.27 mg/L ammonia, which would be in compliance with the Fish and Wildlife Service criteria for acute releases of 1.93 mg/L. The same logic can be applied to the chronic concentration at the edge of the specified regulatory limit of 2500 downstream. The concentration measured by HLA at the shoreline was about 2.2 mg/L ammonia. The commensurate concentration after remediation would be 2.2 x 0.0114 x 10 = 0.25 mg/L ammonia, which is within the regulatory limit set for chronic releases by the Fish and Wildlife Service [this analysis is expanded in the addendum].

4. Conclusions

The PAHL staff performed an analysis of the discharge of ammonia from the Atlas tailings pile and its fate in the Colorado River. The staff conducted several calculations to determine the effectiveness of planned remediation of the Atlas site with regard to concentrations of ammonia in the Colorado River. The first set of calculations estimated the fluxes of ammonia leaving the tailings pile, entering the river and being transported down river. The staff estimated that there were approximately 900,000 grams of ammonia leaving the tailings pile per day during the time when the pile was in active operation and there was a wet pond on the surface. This estimate was based on an infiltration rate calculated from the measured decrease in water level in the pile, and on measured ammonia concentrations from wells in the pile. The estimate of ammonia release to the river was about 236,000 grams per day on the basis of concentrations and water levels in riverside well points. The estimate of ammonia being transported downstream in the Colorado River within 50 ft of the bank was about 263,000 grams per day.

The staff estimates that there was considerable uptake of water and transpiration by the Tamarix on the bank, and that this is likely to account for a significant loss of ammonia (more than half) before it reached the river. The staff believes that Tamarix or other phreatophytes such as willow and cottonwood will remain a major factor in the water and ammonia balance for the regulatory time of interest.

The staff also estimates that there will be a considerable fluctuation of contaminants into the Colorado River because of large-scale changes in river stage, especially during spring melt. These water level changes will cause reversals of the hydraulic gradient in the water table

aquifer, which can lead to the buildup of contaminants in the bank and release at considerably greater rates once the water level falls. When these large rates of contaminated groundwater release coincide with low river flow rates, high concentrations could exist in the river. The staff estimates that peak concentrations could be a factor of up to 10 times greater than those measured by the applicant in its 1997 field study (HLA, 1998), but that this would occur infrequently.

On the basis of its analysis, the staff has reached the following conclusions about the behavior of the Atlas system, and the likelihood that the site will comply with regulatory standards for discharge of ammonia into the Colorado River:

- On the basis of the good agreement among the fluxes of ammonia, including the likely loss through transpiration, the staff was able to estimate with confidence that the likely infiltration rate on the pile must have been on the order of 50 gallons per minute. The importance of this estimate is that a low-permeability clay cap would effectively remediate the site by reducing infiltration to low levels. A low permeability cap with 10^{-7} cm/sec permeability would reduce infiltration to 5.7 gpm, and a 10^{-8} cm/sec permeability cap would reduce infiltration to 0.57 gpm. These estimates assume that the infiltration of the site is equal to the cap permeability under a unit hydraulic gradient. Because flux is proportional to infiltration rate, the staff would expect up to a two order-of-magnitude decrease in flux for a 10^{-8} cm/sec cap. The staff also suggests that under present-day conditions without a pond on the surface, recharge on the site because of precipitation might be much smaller regardless of the type of cover imposed. Studies of infiltration through caps on tailings piles (DOE, 1991) and infiltration in thick alluvium at Yucca Mountain, Nevada (DOE, 1998), indicates that there is little or no net infiltration under dry desert conditions in soil or deep alluvium.

- The staff believes that the higher concentrations along the shoreline of the river observed by the State of Utah are inconsistent with calculations of mass flux of ammonia on land. A possible explanation of this discrepancy is that the measured ammonia concentrations were a result of transient releases resulting from the outflow of bank storage from higher river stage, and are not a true indication of the steady state releases to the river.

- The staff believes that if a 10^{-8} cm/sec cap were placed on the tailings pile, the site would comply with the accute ammonia standard within the mixing zone of 1.93 mg/L, and the chronic ammonia standard of 0.38 mg/L at the downstream extent of the mixing zone. The staff also believes that episodes of high ammonia concentration in the river will be infrequent, caused by periods of relatively high groundwater flux coinciding with relatively low river flow. If the standard could be restated to recognized the low frequency of these episodes (e.g., the concentration is less than the standard 95% of the time), the staff would have higher confidence in compliance.

5. Uncertainties in calculations and recommendations for improvement

Many of the calculations performed in this study were simplified, reflecting the relatively incomplete nature of the data set available and in some cases schedule limitations. Additional refinements to the calculations might be able to improve the estimates of river concentration and the effectiveness of remediation. These improvements include:

- Improve the groundwater transport model. The one-dimensional model of transient groundwater flow did not include the possible infiltration from the surface during periods of significant overbank flooding, or the removal of water by transpiration from the Tamarix. Both these phenomena could be significant. Although the effects were taken into account empirically, it would be possible to modify the one-dimensional model to account for all the phenomena simultaneously, thereby reducing this modeling uncertainty. Another improvement to the groundwater model would be to represent the aquifer in two dimensions laterally. The current one-dimensional model might overestimate the peak release of ammonia because it would predict release at every point along the bank in synchronization. A model that was distributed laterally as well as longitudinally might spread out the releases, leading to smaller peak concentrations in the river.

- Improve river mixing model. The changes in concentration with distance and time because of changes in river flow rate were estimated empirically only and not quantitatively modeled. River dispersion models exist that could be used to estimate the expected nature of the pollutant plume with changing flow rates in the river. There are sufficient measurements of concentrations in the river to allow calibration of such a model, but additional data such as more accurate river cross-sections in the area of the mixing zone, tracer experiments and velocity transects would improve the predictions.

- Uptake of water and dissolved chemicals by the Tamarix has been predicted to play an important role in the ultimate release to the Colorado River. Quantitative measurements of chemical contaminants in the leaves and wood of the Tamarix would serve to validate this presumption.

- Because release of contaminated water from bank storage may play a role in causing periods of high concentration in the river, it would be useful to institute a testing program to capture this effect. For example, concentration in the river could be measured at a single point, either continuously or at close time intervals, along with head and concentration at well points on shore near the river measurement station. Collecting these data over a few months, especially when large fluctuations in the river stage were expected, would serve to validate this model.

6. References

Atlas Corporation Moab Mill, Moab, Utah, prepared for the U.S. Fish and Wildlife Service, Salt Lake City, UT.

Chow, V.T., *Open Channel Hydraulics,* McGraw Hill, New York, 1959

Codell, R.B., K.T. Key, and G. Whelan, "A collection of mathematical models for dispersion in surface water and groundwater", NUREG-0868, U.S. Nuclear Regulatory Commission, 1982.

DOE, 1991, "Analysis of infiltration through a clay radon barrier at an UMTRA disposal cell", U.S. Department of Energy, UMTRA Project Office, Albuquerque Operations Office, January 1991.

DOE, 1998, "Viability Assessment of a Repository at Yucca Mountain", Department of Energy, Las Vegas Nevada.

Gay, L.W., and L.H. Fritschen, "An energy budget analysis of water use by saltcedar", Water Resources Research, Vol 15, no 6, December 1979

Harding Lawson Associates (HLA), 1998, Colorado River Sampling Report Atlas Uranium Mill and Tailings Site, Moab, Utah, prepared for Atlas Corporation, Jan 23, 1998

Oak Ridge National Laboratory, (ORNL/GJ), 1998. "Limited Groundwater Investigation of the Atlas Corporation Moab Mill, Moab, Utah" , Oak Ridge National Laboratory, Grand Junction, Colorado, January 9, 1998.

MathSoft, 1993 *S-Plus Reference Manual*, routine SUPSMU, MathSoft, Inc., Seattle WA, 1993

McWhorter, D. and D.K. Sunada, *Ground-Water Hydrology and Hydraulics*, Water Resources Publications, Fort Collins CO, 1979

Mussetter, R.A., M.D. Harvey, "Geomorphic, Hydraulics and Lateral migration characteristics of the Colorado River, Moab", Mussetter Engineering Inc, Fort Collins, May, 1994

Sinclair, W. memorandum from William Sinclair to Don Ostler, State of Utah, May 3, 1995.

Smith, S. University Nevada Las Vegas, personal communication, Jan 27, 1999.

Utah Division of Radiation Control, 1996, State Update Report for Intensive Ammonia

Sampling of Colorado River and Request for Additional Studies: Atlas Uranium Tailings Near Moab, Utah, Letter Report, Utah Division of Radiation Control, Salt Lake City, Utah, December 11, 1996

Utah Division of Radiation Control, 1997, Atlas Uranium Mill Tailings near Moab, Utah: January y, 1997, Utah DEQ Intensive Colorado River Water Quality Sampling Results, Need for Additional Studies, Letter Report, Utah Division of Radiation Control, Salt Lake City, Utah (June 20, 1997)

Weisborn, D. , "Saltcedar impacts on salinity, water, fire frequency and flooding", *The Saltcedar Management Workshop,* June 12, 1996, University of California, Rancho Mirage California

Addendum to Atlas Ammonia Report

by Richard Codell

A.1 Introduction

This addendum amplifies the discussion about the concentration at the downstream edge of the mixing zone and how it responds to changes in flow. This topic was discussed in section 3.1.4 of the report "Analysis of Release and Transport of Ammonia from the Atlas Tailings Pile and its Fate in the Colorado River" by the same author. The previous analysis discussed the belief that the dilution in the river would be less than proportional to the flow rate in the river, however this factor was not incorporated into the calculations of peak concentration. The present analysis treats the relationship between the river flow rate and concentration explicitly, especially for the concentration at the downstream extent of the specified mixing zone. This analysis should also apply, at least partially, to the determination of the maximum concentration.

A.2 Concentration at Edge of Mixing Zone

The downstream extent of the mixing zone is defined as the point at which the maximum plume concentration drops below 0.38 mg/L ammonia. To estimate how the mixing zone will change with changes in river flow rate, consider the concentration measured in the river at the regulatory limit of 2500 ft downstream of the upper extent of the pile, and determine how concentration will respond to shifts in the flow rate alone.

A.2.2 Assumptions of analysis

The analysis makes the following assumptions, which are reasonably well founded at this site and location:

- The system is at steady state.

  Rationale: At the time scale of interest, the transients in the river are much faster than the groundwater transients, so we can reasonably assume that the system is at steady state.

- The releases to the river emanate from a point source on shore.

  Rationale: Since we are calculating the concentration at a large distance from the point of release, it is reasonable to assume a point source release at the bank. The distance over which the groundwater plume is spread would be small compared to the distance of the downstream extent of the mixing zone.

- The river channel near shore has a constant slope.

  Rationale: The measurements out to 50 ft indicate that the river is shallow, and approximately constant slope. Since we are most concerned with the plume at $y = 0$ (near shore), deviations from this approximation further from shore should not affect the solution adversely. This assumptions allows us to conclude that the plume will remain approximately the same shape at lower river stage, only translated further away from the shoreline.

For the distances that the plume extends downriver, the effect of the opposite shore can be treated as insignificant. In this case, the dilution of the plume in the river at steady state will be proportional to the square root of distance from the point of release. In terms of Figure 2 in Codell et al (1982), the dilution immediately next to the shoreline can be expressed as:

$$\frac{C}{W/Q} = \gamma\sqrt{\frac{Q^2}{Dx}} \tag{1}$$

where C = the concentration in the river next to the shore, W = the release rate of ammonia, Q = the river flow, x = downstream distance and D = the dispersion coefficient:

$$D = \overline{E_y u d^2} \tag{2}$$

where E_y = the dispersion coefficient across the river, u = velocity in river, and d = depth.

As noted in Section 3.1.3 of the main report, for a flow rate of 2550 CFS representing the 10th percentile low flow, the velocity u would decrease to 76% of the velocity for the benchmark flow rate of 5275 CFS corresponding the the HLA (1998) sampling conditions. At a fixed location x downstream of the point of releases, the relative concentration under conditions of lower flow can be calculated as the ratio of Equation 1 evaluated for the two conditions. In this case, most of the terms would cancel, leading to the result:

$$\frac{C}{C_0} = \sqrt{\frac{D_0}{D}} = \sqrt{\frac{E_{y,0}u_0}{E_y u}} \tag{3}$$

where the zero subscript refers to the benchmark values. If E_y is independent of velocity, then

the concentration at the lower flow rate would be:

$$C = C_0 \times \sqrt{\frac{1}{0.76}} = 1.147 C_0 \tag{4}$$

Sayre et al (1973), however suggest that the dispersion factor is approximately proportional to the velocity. If this is the case, then the concentration will be inversely proportional to the velocity:

$$C = C_0 \left(\frac{1}{0.76}\right) = 1.316 C_0 \tag{5}$$

In either case, the concentration is not directly proportional to flow rate, but rather to a reduced power of flowrate. For the latter case, the concentration would be proportional to the flow rate raised to the power $n = 0.378$, i.e.,

$$\frac{C}{C_0} = \left(\frac{Q_0}{Q}\right)^{0.378} \tag{6}$$

Considering other factors that would tend to increase concentration in the river, such as the compression of streamlines of groundwater flow at lower stages, it would be conservative to use a power of $n = 0.5$. The concentration factor calculations discussed in Section 3.2.4 were revised by inserting a square root dependency (i.e., $n = 0.5$) on flow rate into the dilution calculations. The results of this revision were as expected, showing a smaller concentration factor resulting from changes in river flow coupled to bank storage. For $\alpha = 1$ ft, 10 particles per day, and no smoothing, the peak C_f was about 11 as opposed to $C_f = 15.46$ for the case of $n = 1.0$. The 99th percentile values were 5.08 versus 6.38 for n=0.5 and n=1.0, respectively.

Taking into consideration the factors tending to reduce C_f discussed in Section 3.2.4, a reasonable estimate that can be applied to the concentration at the edge of the mixing zone would be $C_f = 5$.

A.2.2 Calculation of concentration at edge of mixing zone

If we consider the end of the mixing zone to be 2500 ft downstream of the upper reaches of the tailings pile, the measured shoreline concentration from the HLA study was 2.2 mg/L ammonia (HLA, 1998). Taking credit for a 10^{-8} cm/sec cover on the tailings pile would offer a reduction in concentration by a factor of 0.0114. Combining this with the C_f estimate of 5 would yield a concentration under remediated conditions of 2.2 x 0.0114 x 5 = 0.125 mg/L ammonia, which would be in compliance with the Fish and Wildlife Service criteria for

chronic releases.

A.3 Calculation of acute concentration

If this analysis also applies to the calculation of the acute concentration, the acute concentration would be reduced from 0.27 to 0.135 mg/L. The biggest uncertainty in this case is that the assumption about the release occurring from a point source would no longer apply, since the maximum concentration would occur near the area of groundwater discharge to the river. However peak concentration is less of a problem in the Atlas case than is the concentration at the downstream extent of the mixing zone.

A.4 Additional Reference

Sayre, W.W., and T.P. Yeh, "Transverse mixing characteristics of the Missouri River downstream from the Cooper Nuclear Stations", IIHR Report no. 145, Iowa Institute of Hydraulic Research, April 1973.

Figure 2 - Cumulative Distribution Function,
Cisco, Utah gage, 1965-1977

CDF

Flow Rate, CFS

Figure 3

Figure 4

1. Plume of groundwater compressed
2. River slows to 76% velocity
3. Turbulance decreases, but longer travel time
4. About a factor of 2 or less increase in C

Sampling stage = 5275 CFS

Low flow = 2550 CFS

(Not to scale)

High stage plume

Low stage Plume

Atlas

Figure 5 - Coupled surface water/groundwater system

Transpiration by tamarix =
4.3 ft/yr = 9.3 cu ft/dy = about 60% loss

Colorado River

50 Gallons per minute

900,000 grams ammonia per day

231,000 grams ammonia per day

263,000 grams ammonia per day

Figure 6

At sample flow = 5275 CFS

At low flow = 2550 CFS (90th percentile)

Atlas side

Figure 7 - Hydrograph of Stage versus Flow

Stage above sampling level at 5275 CFS, ft

Flow, CFS

Figure 8

Figure 9

Head above datum = 40 ft at 5275 CFS

Days since 1/14/89

Time, days

Bank discharge and recharge, Cubic ft/day per ft of shoreline

From river   To river

Figure 10 - Gain and release from bank

Figure 11

Time, days   Concentration factor

Figure 12

Figure 13
Concentration factor for alpha = 1 ft, with 0, 2 and 5 ft smoothing windows

Figure 14

Concentration factor

CDF

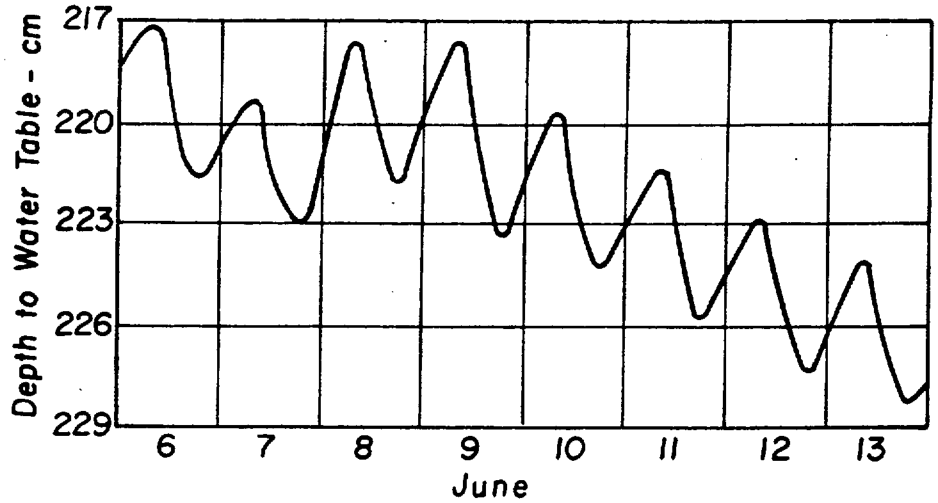


Figure 1 Water level fluctuation due to phreatophyte transpiration

Figure 2 - Cumulativ istribution Function, Cisco, Utah gage, 1965-1977

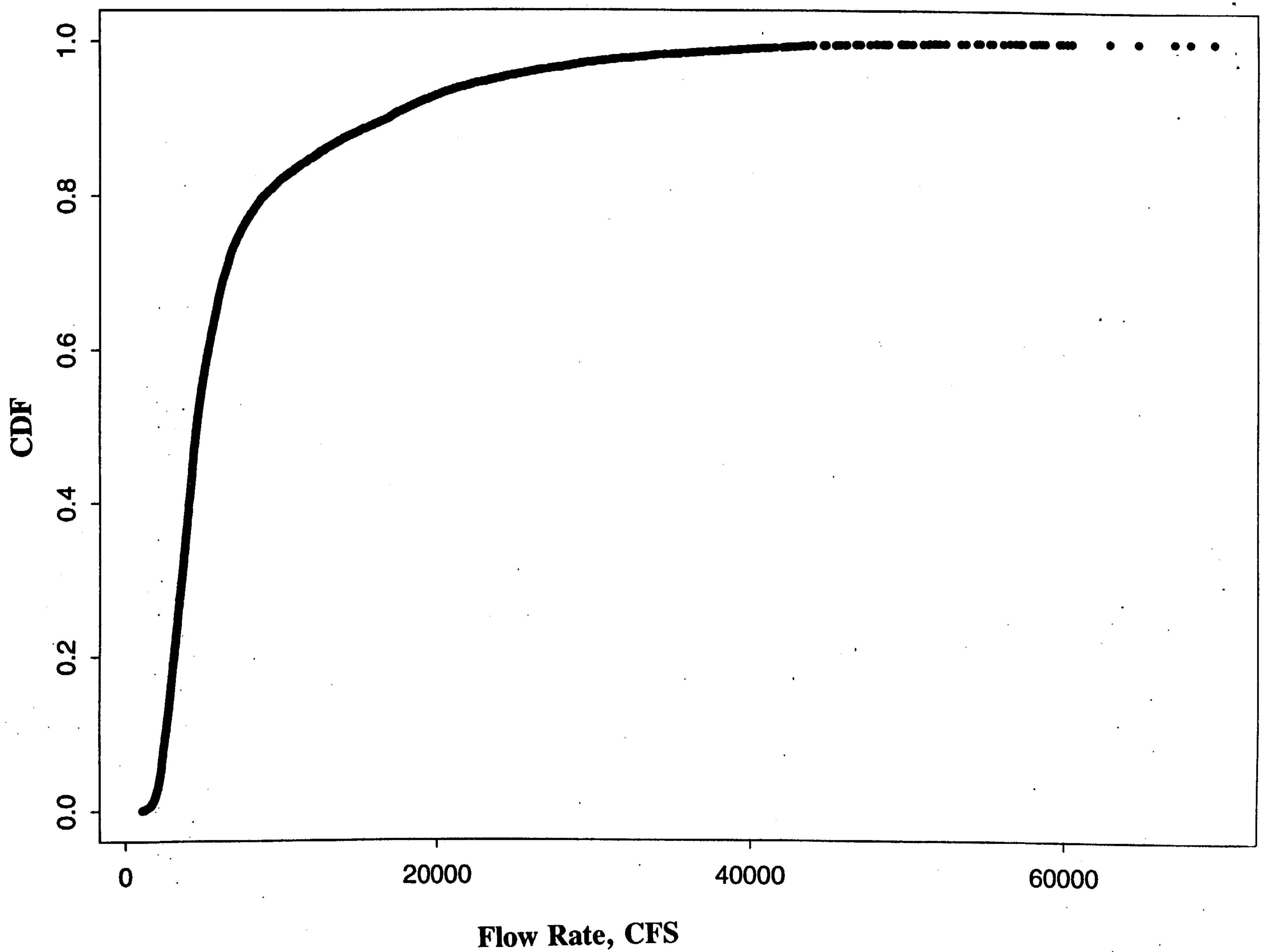
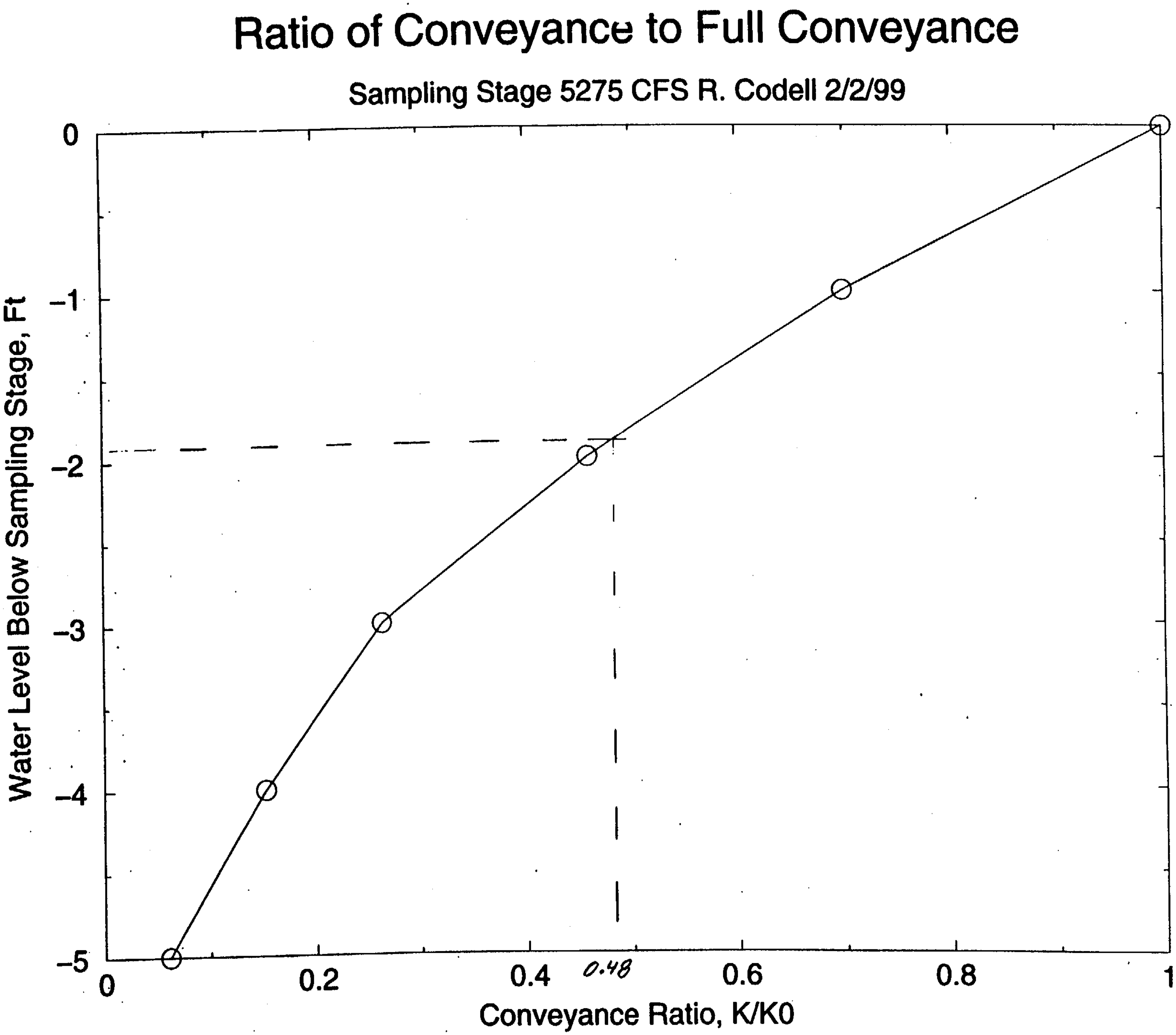


Figure 3



Ratio of Conveyance to Full Conveyance
Sampling Stage 5275 CFS R. Codell 2/2/99
0
−1
−2
−3
−4
−5
Water Level Below Sampling Stage, Ft
0
0.2
0.4
0.48
0.6
0.8
1
Conveyance Ratio, K/K0

Figure 4

Effect of Low flow on dilution in River

1. Plume of groundwater compressed
2. River slows to 76% velocity
3. Turbulance decreases, but longer travel time
4. About a factor of 2 or less increase in C

Atlas →

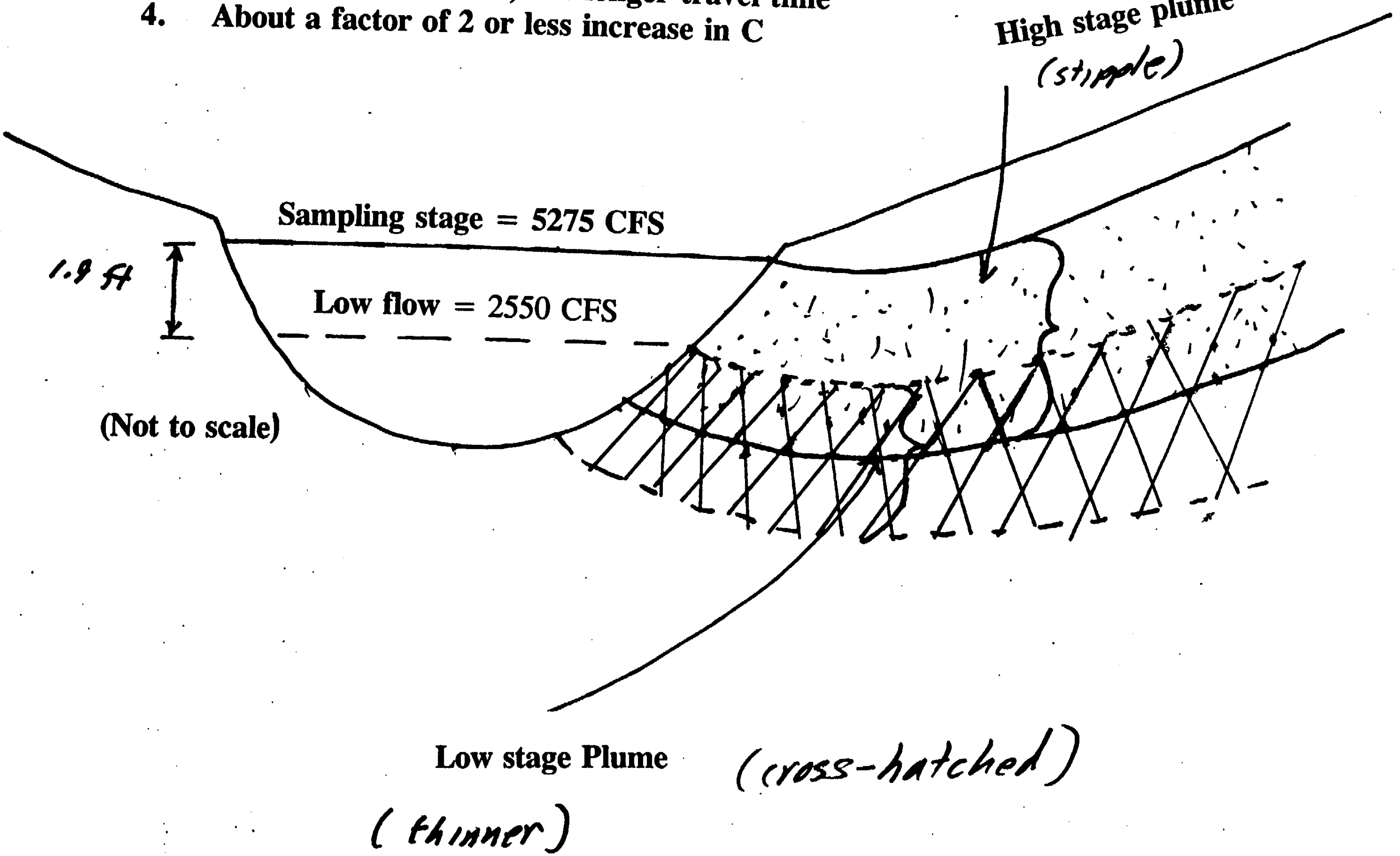
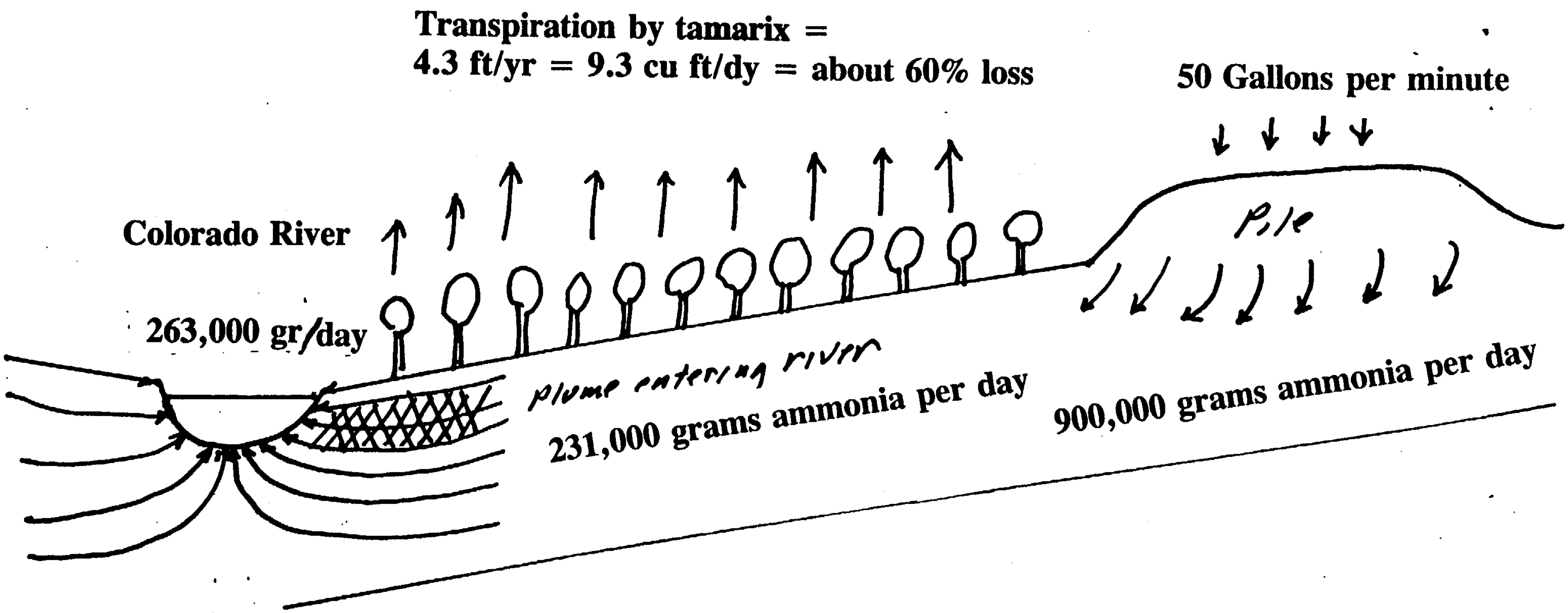


Figure 5 - Coupled surface-water/groundwater system



1. Reduction of NH_3 flux by 10^{-7} cm/sec cap = 0.114
   10^{-8} = 0.0114

2. Increase C in river due to low flow ≤ factor of 2

3. Increase C in river because of release from bank storage factor of 10

Figure 6

Approximate Cross Section of Colorado River

Section 3–3a, R. Codell 2/1/99

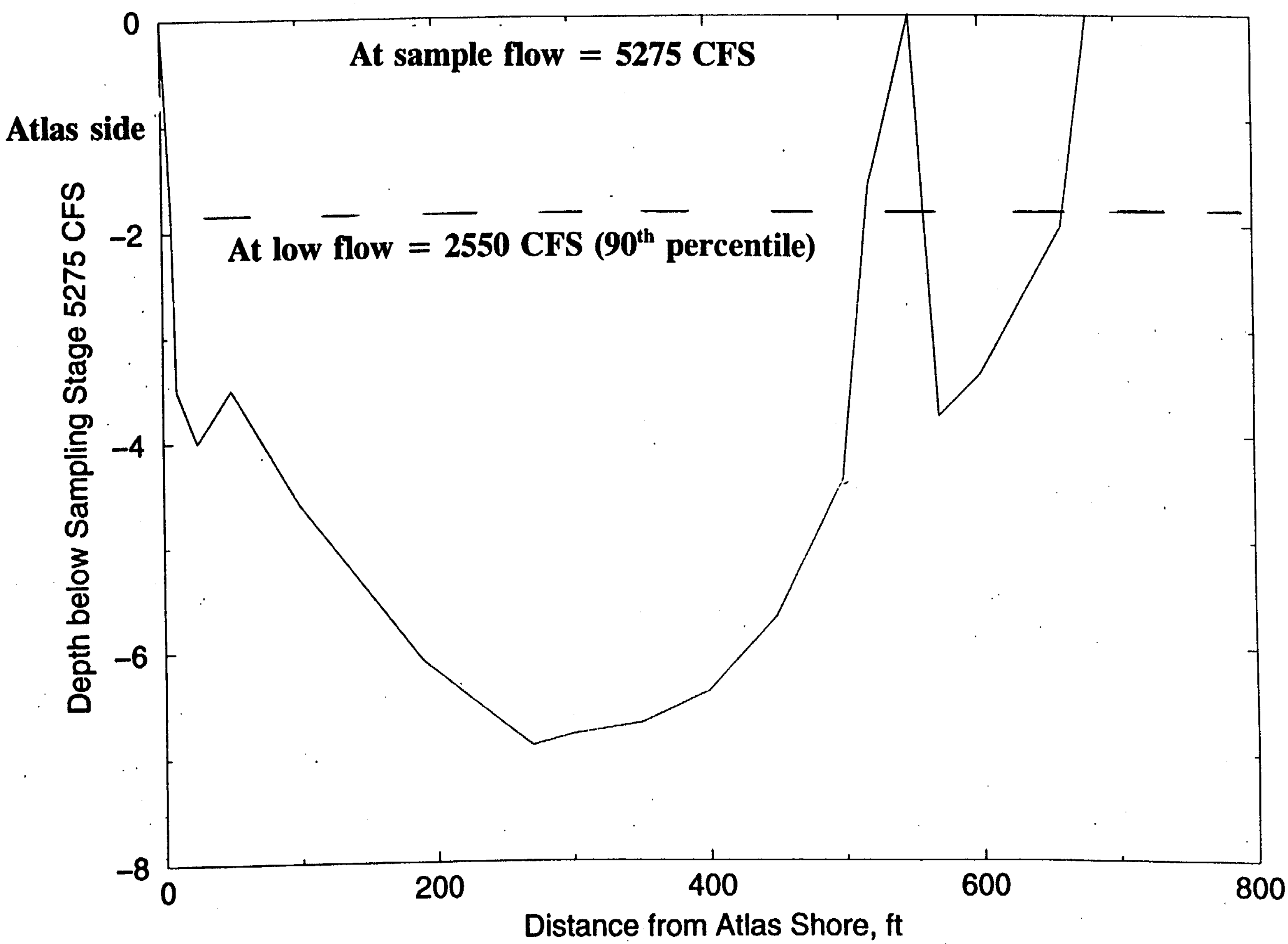


Figure 7 - Hydrograph of Stage versus Flow

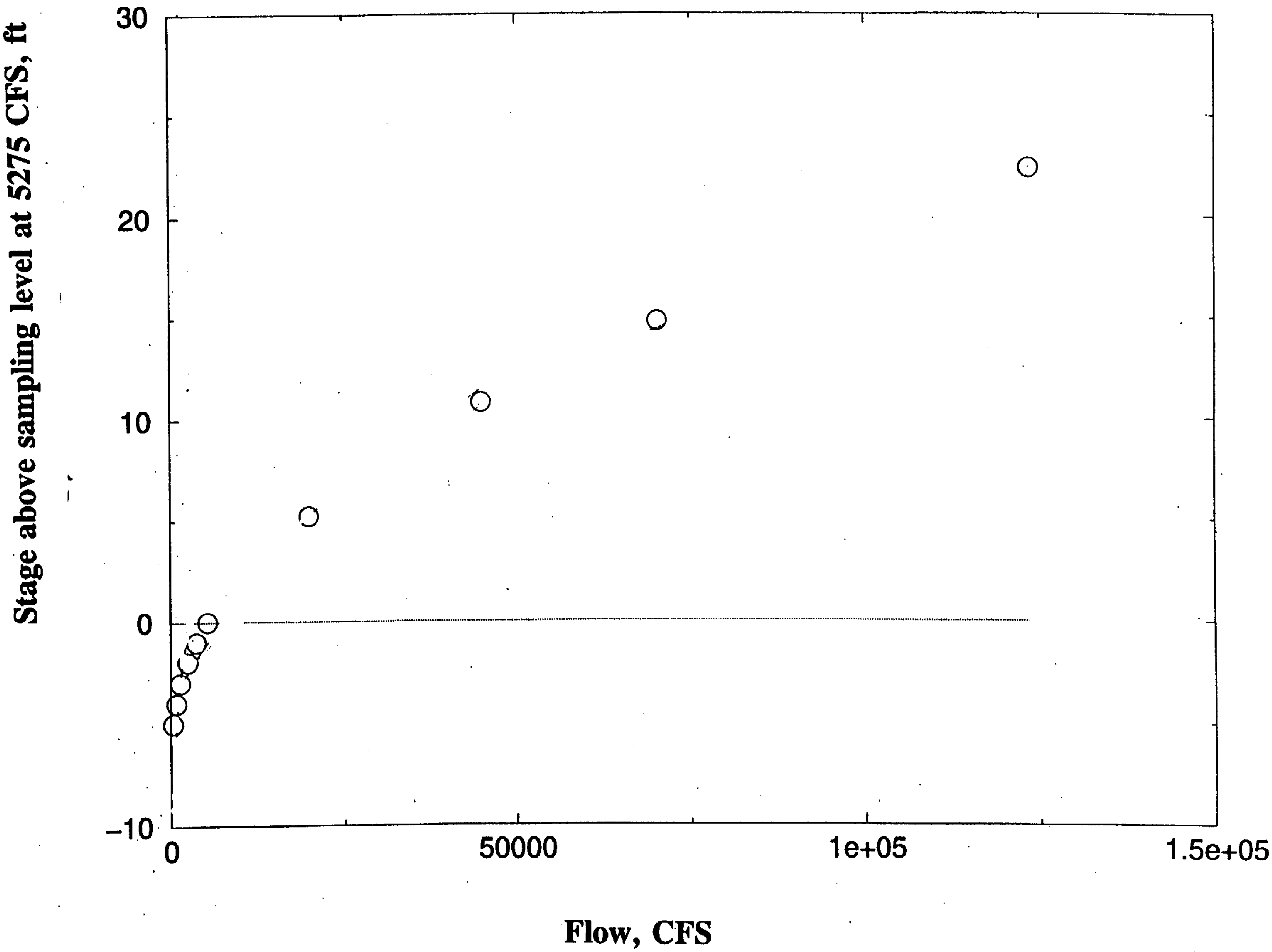
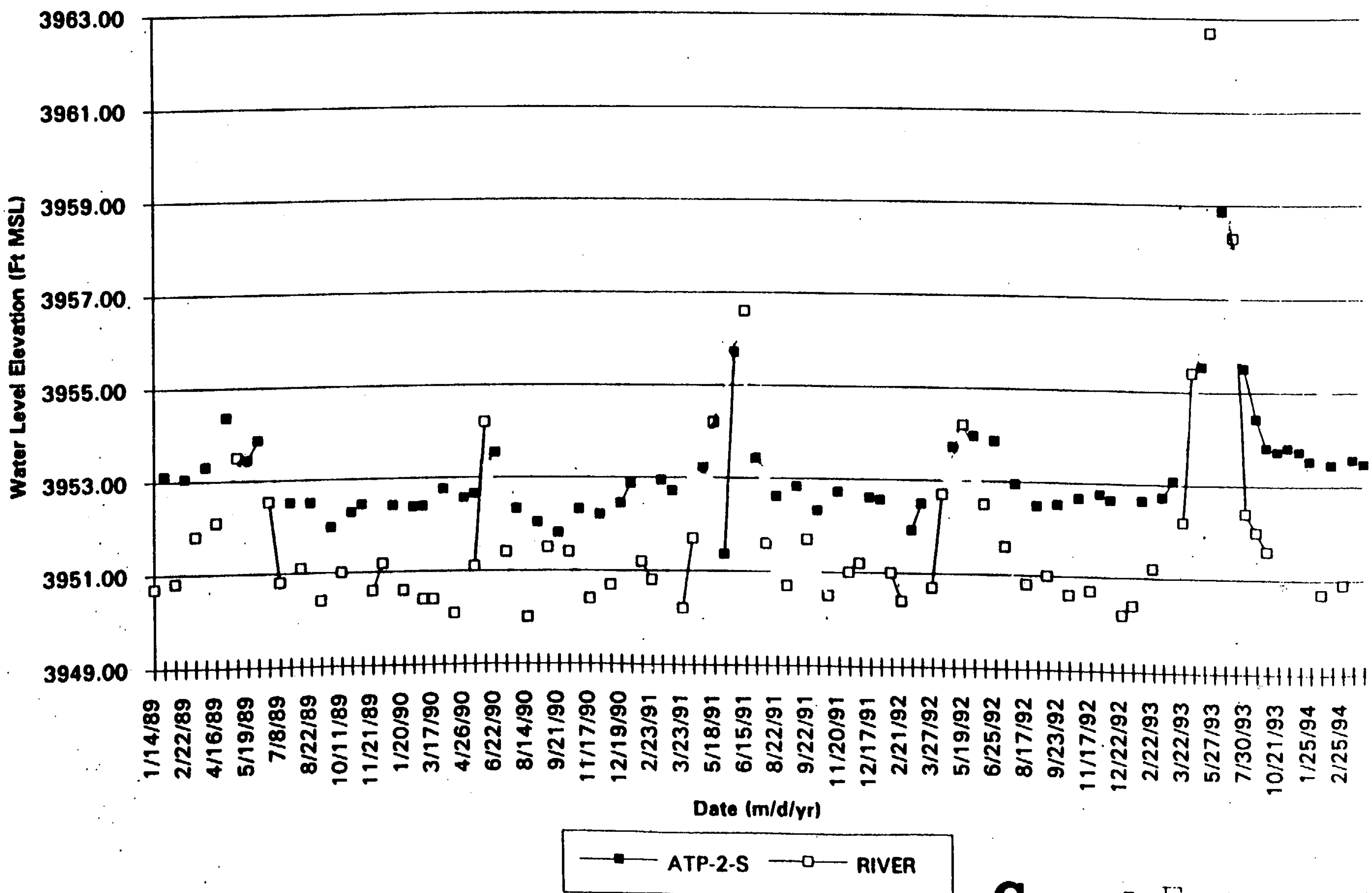


Figure 8

Water Level Comparison Between Piezometer ATP-2-S and Colorado River

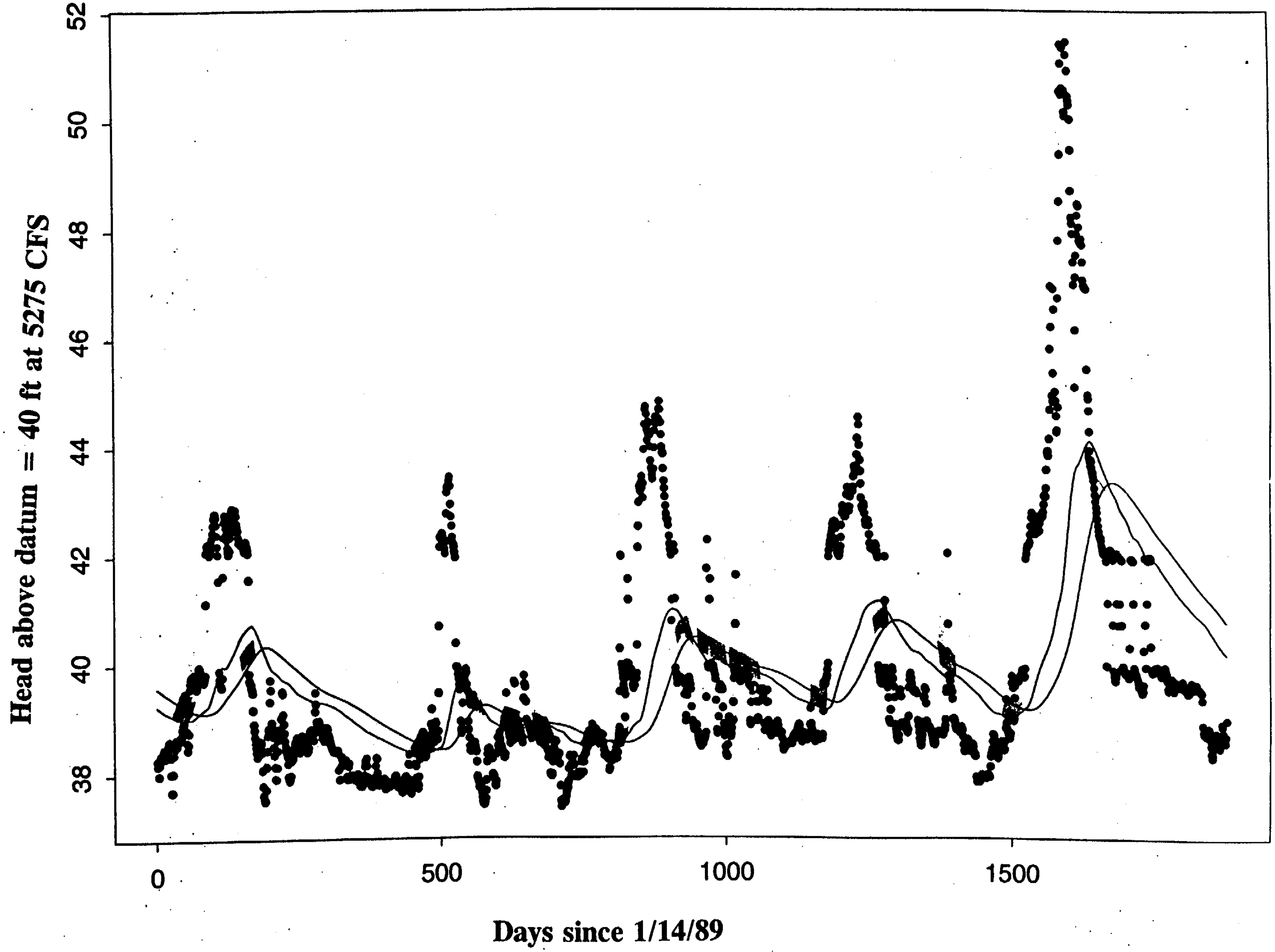


CanonieEnvironmental

XSECTA.XLS Chart 16 (6/29/94)

Figure 9

Water level at river, 5(ft and 1000 ft from shore, 1/14/89 to 2/20/94



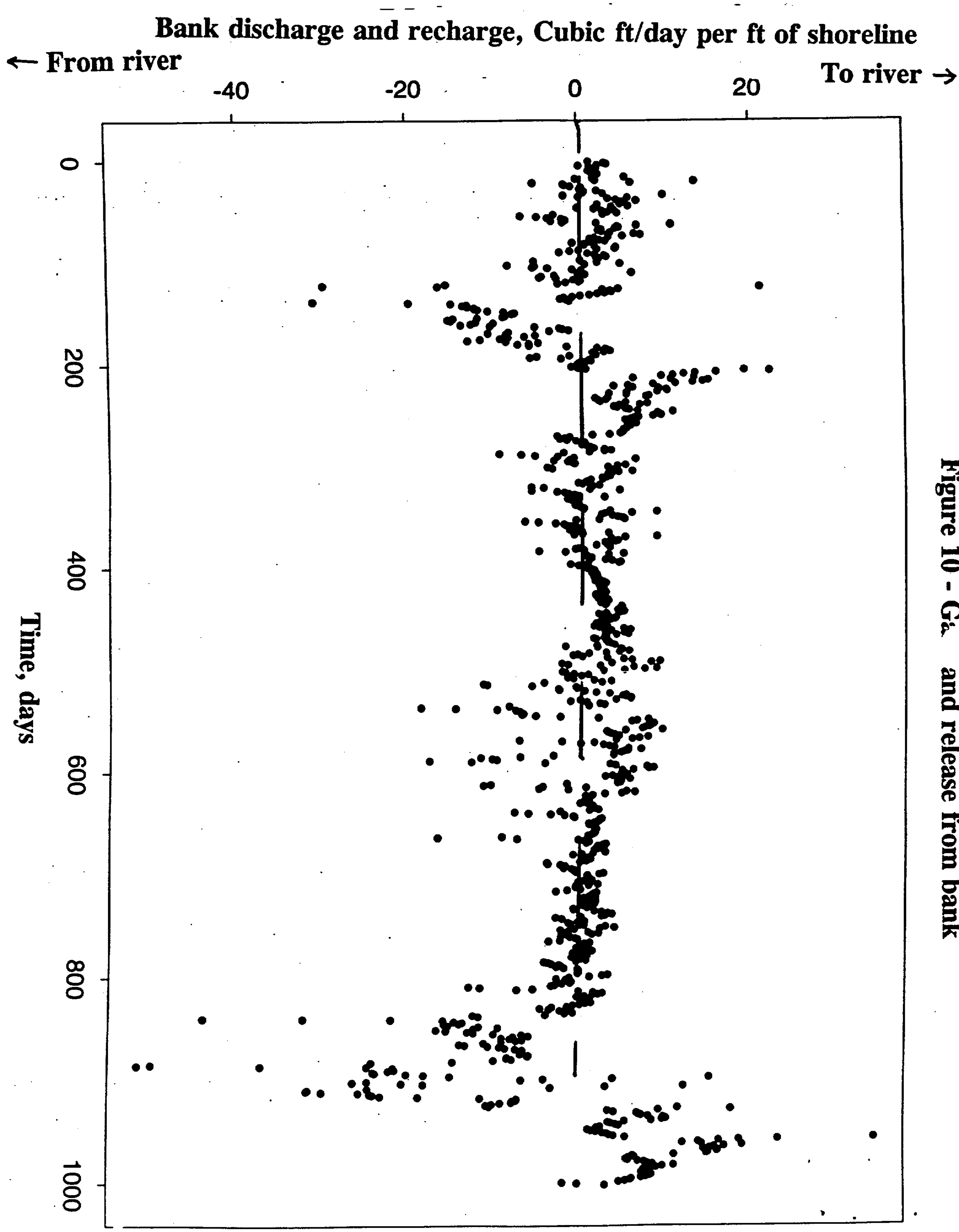


Figure 10 - G[illegible] and release from bank

Figure 11

Concentration factors, no dispersion (•) and 1 ft dispersion (solid line)
R. Codell 2/16/1999

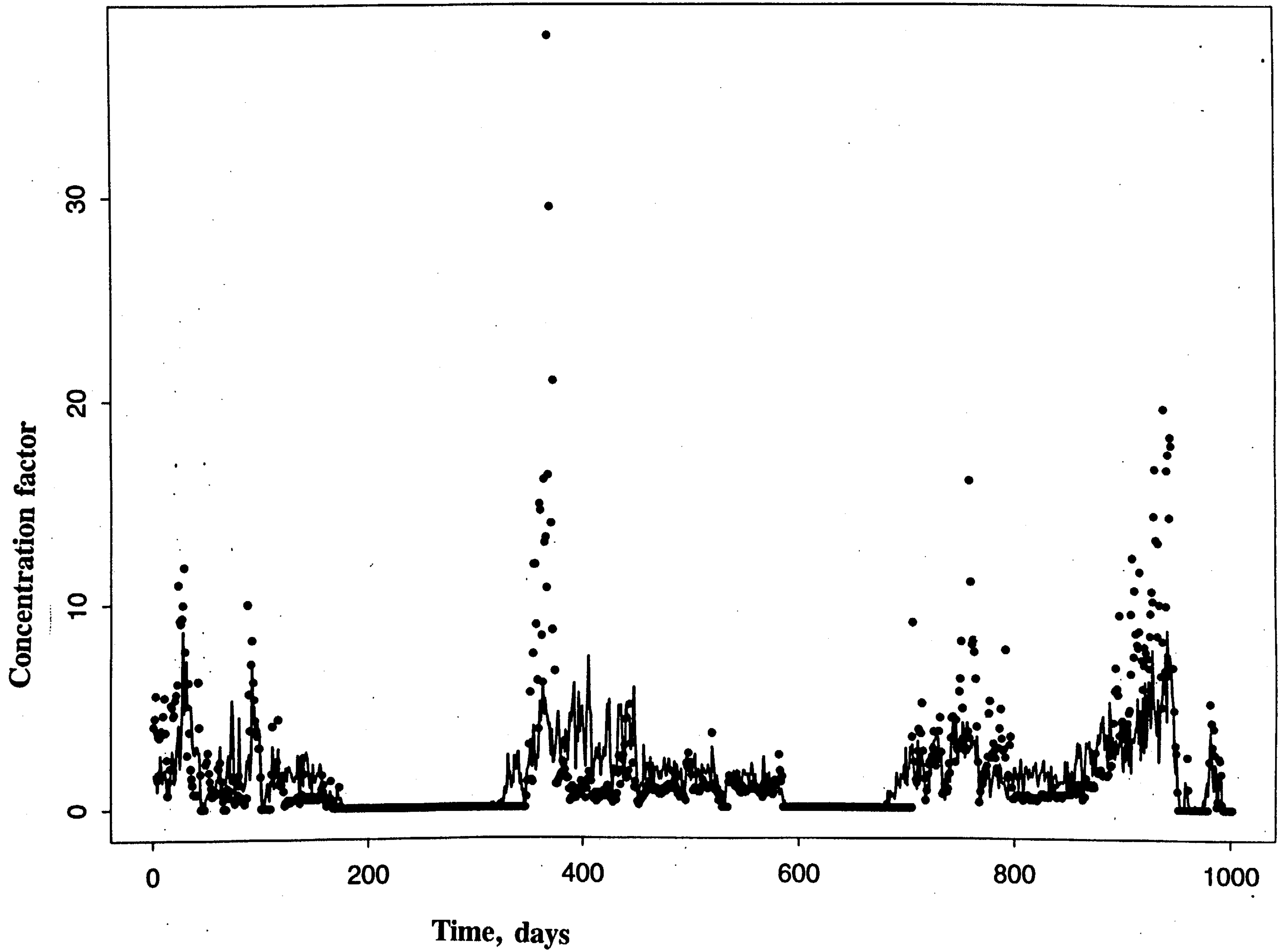
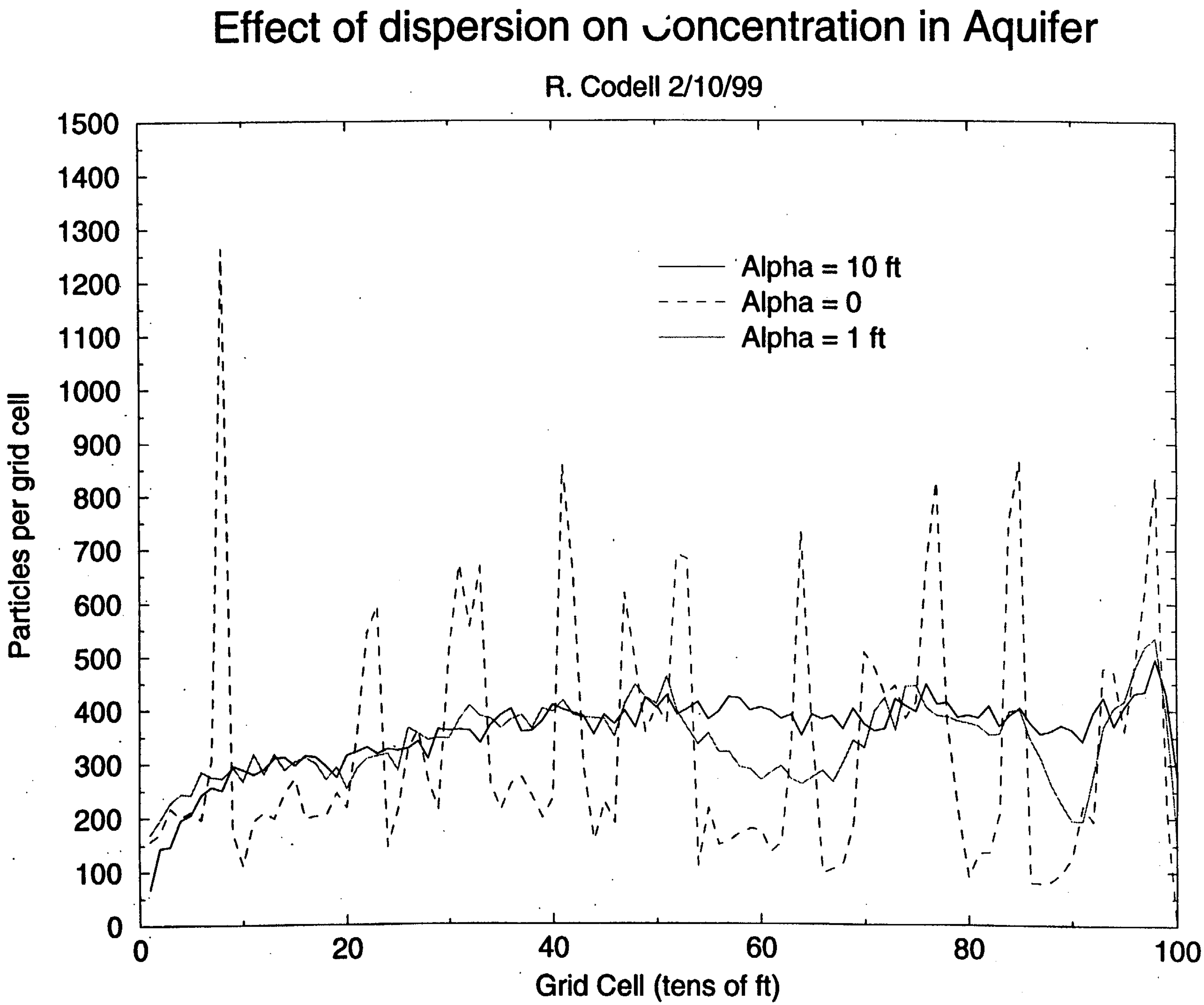
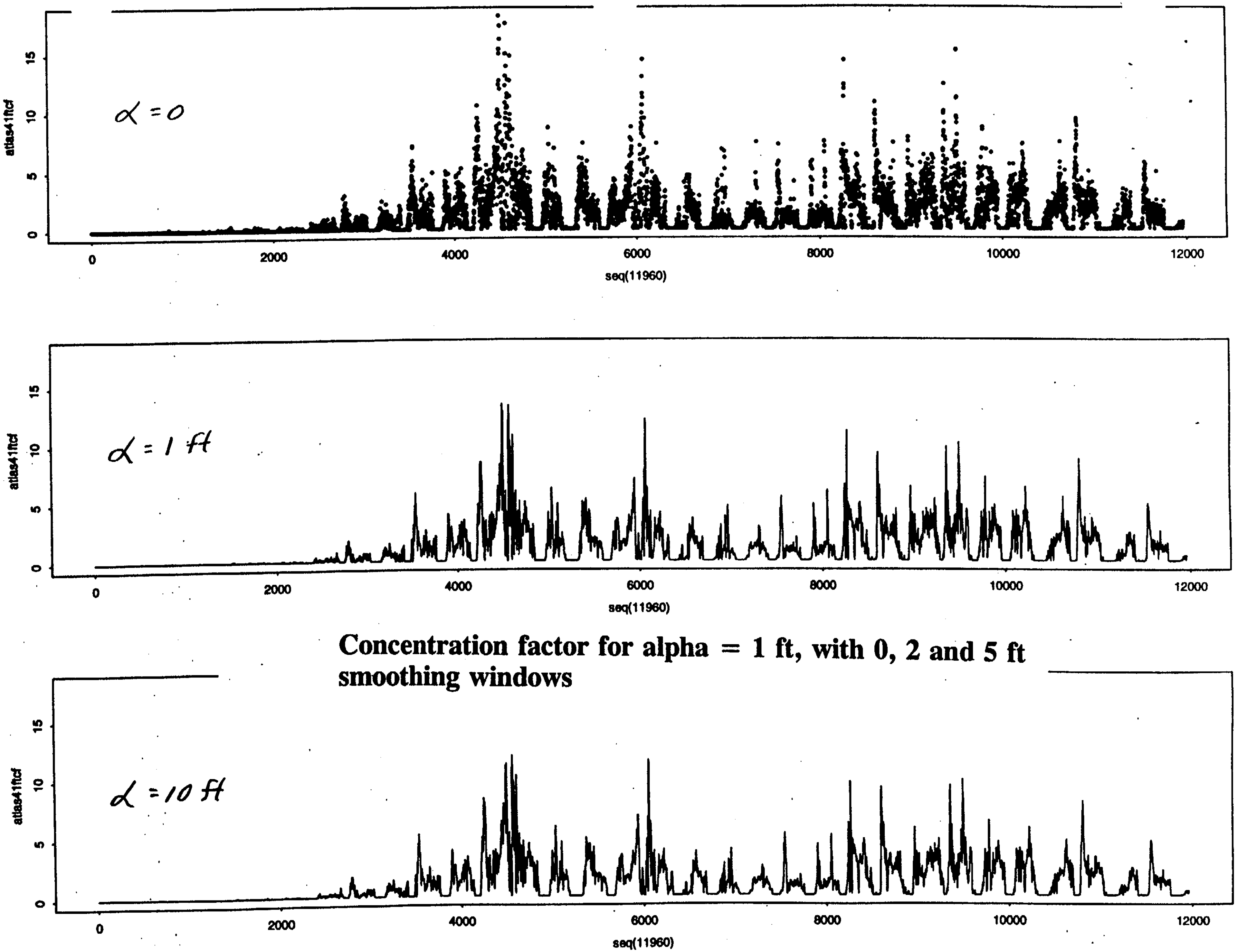


Figure 12



Effect of dispersion on Concentration in Aquifer
R. Codell 2/10/99
Particles per grid cell
Grid Cell (tens of ft)
Alpha = 10 ft
Alpha = 0
Alpha = 1 ft
0
100
200
300
400
500
600
700
800
900
1000
1100
1200
1300
1400
1500
0
20
40
60
80
100

Figure 13



Concentration factor for alpha = 1 ft, with 0, 2 and 5 ft smoothing windows

Figure 14

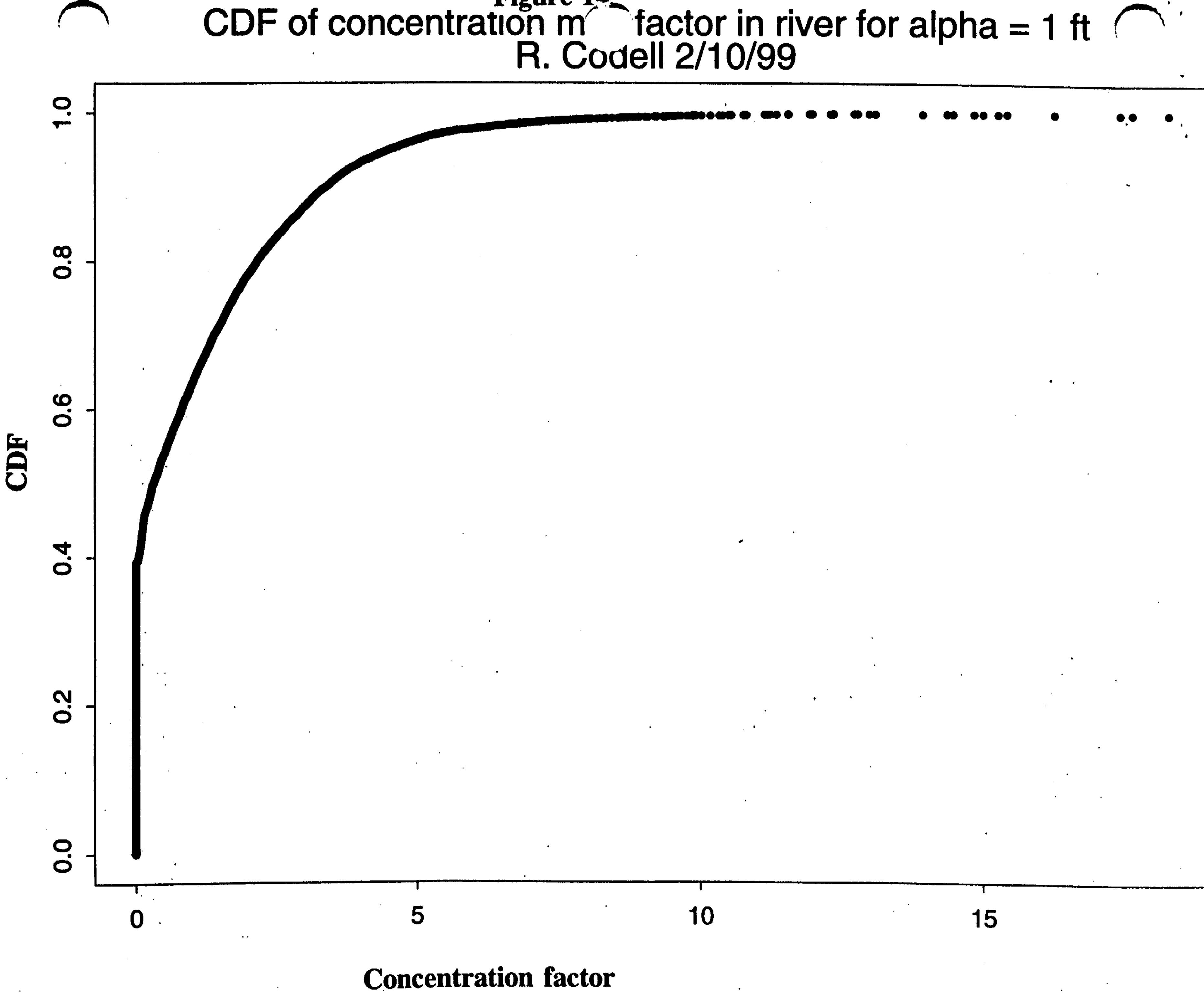

CDF of concentration m factor in river for alpha = 1 ft
R. Codell 2/10/99
1.0
0.8
0.6
0.4
0.2
0.0
CDF
0
5
10
15
Concentration factor

Table 1 – Groundwater [illegible]ux of Ammonia into River

Well Location	Gradient to River i	$\bar{i}$	C mg/L	Δx, ft	ΔC	$\overline{\Delta C}$	$\overline{\Delta C}\,\bar{i}\,\Delta x$	Cum $\overline{\Delta C}\,\bar{i}\,\Delta x$
TP11	.0033		3.5		.0049			
		.005		600		.00385	2.31	2.31
TP01	.0067		0.41		.0028			
		.0084		600		.021	12.6	14.91
TP02	.01		4		.04			
		.01		750		.053	39.75	54.66
TP03	.01		6.5		.065			
		.0075		600		1.2	720	724.61
TP04	.005		4.65		2.33			
		.00425		480		1.84	883.2	1157.81
TP12	.0035		782		1.74			
		.003		500		1.54	770	2429.86
TP13	.00244		710		1.73			
		.0058		480		6.52	3129.6	5557.46
TP14	.00876		1285		11.3			
		.0067		500		6.65	3325	8882.46
TP15	.00965		110		2.0			
		.0049		480		1.02	489.6	9372.01
TP16	.0048		7.1		.034			
		.0030		650		.021	13.65	9385.21
TP17	.0011		2.3		.008			
		.0011		700		.008	5.6	9391.37
TP18	.001		8.4		.008			

at TP15.2, $\sum \overline{\Delta C}\,\bar{i}\,\Delta x \approx 9225.18 \frac{mg}{L} ft \times 40 ft \times 22 \frac{ft}{day} \times \frac{28.5 L}{ft^3} \times \frac{g}{1000 mg}$

Total Ammonia = 235,526 grams/day

Table 2 - Flux of Ammonia in River

Y (ft)	0	10	25	50	(distance from shore)
ΔY (ft)	10	15	25		
$\bar{C}^z$ (mg/L)	2.4	1.25	.35	.145	(vert av C)
$\int_0^y Q\,dy$ (cfs)	0 ft³/sec	11.74	84.4	205.7	(cumulative flow in direction across river)
ΔQ (cfs)		11.74	73.06	121.3	(flow in segment)
$\bar{C}^{zy}$ (mg/L)	~~1.613~~	1.825	.8	.247	(Av C in segment)
$\bar{C}^{zy}\,\Delta Q$		18.52	58.44	29.96	$\Sigma = 106.93 \frac{mg}{L}\frac{ft^3}{sec}$

$$106.93 \frac{mg}{L}\frac{ft^3}{sec} \times \frac{28.5\ L}{ft^3} \times \frac{g}{1000\ mg} \times 86400 \frac{sec}{day} = \boxed{263{,}310 \frac{g}{day}} \text{ Ammonia}$$

Table 3 – Effect of diffusion, Particle density and smoothing on C_f

Case	C_f Mean	C_f Median	C_f 90th %	C_f 95 %	C_f 99 %	C_f Max
5 particles/day no dispersion	1.183	0	3.44	5.94	12.66	82.07
10 part/day no dispersion	1.173	0	3.37	5.59	11.03	52.75
10 part/day α = 1 ft	1.14	0.3	2.38	4.49	7.7	18.25
10 part/day α = 10 ft	1.06	0.37	2.09	4.02	6.38	15.46
10 part/day α = 1 ft smoothing window = 2 days	—	—	—	—	—	14
10 part/day α = 1 ft smoothing window = 5 days	—	—	—	—	—	13

November 30, 1998

MEMORANDUM TO: Elizabeth Q. Ten Eyck, Director
Division of Fuel Cycle Safety
and Safeguards

FROM: John T. Greeves, Director [Signed by]
Division of Waste Management
Office of Nuclear Material Safety
and Safeguards

SUBJECT: APPRECIATION OF SUPPORT FROM SUSAN D. CHOTOO FOR HER WORK ON THE ATLAS FINAL ENVIRONMENTAL IMPACT STATEMENT

I appreciate your cooperation in making Susan D. Chotoo available to support the Division of Waste Management (DWM) in completing the Final Environmental Impact Statement (FEIS) for the Atlas mill tailings reclamation. Currently, DWM expects to issue the FEIS by the end of December. Over the past several years, the staff has been involved in a number of issues related to the Atlas proposal to reclaim 11 million tons of mill tailings in place along the banks of the Colorado River. In order to help DWM ensure the quality of the FEIS, Ms. Chotoo participated in an independent review of the document.

The purpose of this memorandum is to let you know that Ms. Chotoo's support was extremely beneficial, and was integral in helping DWM complete this highly controversial licensing action. She exhibited a keen interest in helping DWM contribute to the success of the FEIS. We appreciate the opportunity to have Ms. Chotoo support us, and hope that she found the experience equally beneficial.

cc: C. Emeigh, FCSS
S. Chotoo, FCSS
K. Carrier, PMDA (OPF)

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UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555-0001

November 30, 1998

MEMORANDUM TO: Elizabeth Q. Ten Eyck, Director
Division of Fuel Cycle Safety
and Safeguards

FROM: John T. Greeves, Director
Division of Waste Management
Office of Nuclear Material Safety
and Safeguards

SUBJECT: APPRECIATION OF SUPPORT FROM SUSAN D. CHOTOO FOR HER WORK ON THE ATLAS FINAL ENVIRONMENTAL IMPACT STATEMENT

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cc: C. Emeigh, FCSS
S. Chotoo, FCSS
K. Carrier, PMDA (OPF)

UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555-0001

April 28, 1999

40-3453

Ms. Susanne Mayberry
Grand County Council
895 Oak Street
Moab, UT 84532

Dear Ms. Mayberry:

I am responding to your e-mail of March 17, 1999, to the White House, in which you expressed concern about Atlas Corporation's uranium mill tailings near Moab, Utah. The site is regulated by the U.S. Nuclear Regulatory Commission (NRC) under Source Material License SUA 917. The licensee, Atlas, has requested NRC approval of a plan to remediate the tailings in place. NRC staff has conducted detailed reviews to determine whether the Atlas reclamation plan meets applicable standards with respect to health and safety and to assess the environmental consequences of the proposed reclamation. In March 1997, NRC issued the "Final Technical Evaluation Report for the Proposed Revised Reclamation Plan for the Atlas Corporation Moab Mill" (Enclosure 1), and in April 1999, issued Supplement 1 to that report (Enclosure 2). NRC staff concluded, that with minor modifications, the proposed plan would meet the applicable health and safety standards. In March 1999, NRC issued the "Final Environmental Impact Statement Related to Reclamation of the Uranium Mill Tailings at the Atlas Site, Moab, Utah," (Enclosure 3), in which it identified conditions that it would require Atlas to meet. By letter dated March 2, 1999 (Enclosure 4), NRC requested Atlas to agree to the conditions identified, which Atlas did in its letter of April 15, 1999 (Enclosure 5). NRC expects to issue a license amendment, approving the proposed reclamation plan, in the near future.

As you state in your e-mail, Atlas has filed for bankruptcy and does not appear to have the financial resources to complete the reclamation or clean up the contaminated ground water on the site. NRC is involved in negotiations to try to maximize the resources that could be used for the reclamation of the site. It is unfortunate that the situation with the Atlas site has reached the point where reclamation may not be completed by the licensee because of financial problems. However, NRC will continue to use its authority to ensure that the site is maintained, and, if resources allow, reclaimed in a manner protective of public health, safety, and the environment.

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If you have any questions, contact King Stablein, the NRC Branch Chief responsible for the Atlas review, or Myron Fliegel, the NRC project manager for Atlas. Dr. Stablein can be reached at (301) 415-7238 and Dr. Fliegel at (301) 415-6629.

Sincerely,

Carl J. Paperiello, Director
Office of Nuclear Material Safety
and Safeguards

Enclosures:
1. Final Technical Evaluation Report (TER) for the Proposed Revised Reclamation Plan for Atlas
2. Supplement 1 to the TER
3. Final Environmental Impact Statement Related to Reclamation of Uranium Mill Tailings at Atlas
4. March 2, 1999, letter from NRC to Atlas
5. April 15, 1999, letter from Atlas to NRC

If you have any questions, contact King Stablein, the NRC Branch Chief responsible for the Atlas review, or Myron Fliegel, the NRC project manager for Atlas. Dr. Stablein can be reached at (301) 415-7238 and Dr. Fliegel at (301) 415-6629.

Sincerely,

[M.J. Virgilio for]

Carl J. Paperiello, Director
Office of Nuclear Material Safety
and Safeguards

Enclosures:
1. Final Technical Evaluation Report (TER) for the Proposed Revised Reclamation Plan for Atlas
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3. Final Environmental Impact Statement Related to Reclamation of Uranium Mill Tailings at Atlas
4. March 2, 1999, letter from NRC to Atlas
5. April 15, 1999, letter from Atlas to NRC

(w/o encl.)

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DATE	4/26/99		4/26/99		4/ /99		4/28/99			

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UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555-0001

August 12, 1999

MEMORANDUM TO: John Surmeier, Chief
Uranium Recovery & LLW Branch
Division of Waste Management, NMSS

40-3453

FROM: Myron Fliegel
Uranium Recovery
and Low-Level Waste Branch
Division of Waste Management, NMSS

Penelope Kinney
Program Management, Policy Development
and Analysis Staff, NMSS

Maria Schwartz
Office of the General Counsel

SUBJECT: PANEL RECOMMENDATION FOR TRUSTEE FOR THE ATLAS RECLAMATION

The panel established to nominate an organization as trustee for reclamation of the Atlas site, has reviewed submittals from five organizations that requested consideration for that position. The panel consisted of Myron Fliegel and Maria Schwartz. Penelope Kinney served as administrative advisor to the panel. Submittals were received from the following organizations:

1) CIMA Energy Corporation, Denver, Colorado;

2) Dames & Moore, and its subsidiary, Rogers & Associates Engineering, in Salt Lake City, Utah;

3) Environmental Technologies Inc., Riverton, Wyoming;

4) Harding Lawson Associates (HLA), Denver, Colorado; and

5) PricewaterhouseCoopers LLP, Houston, Texas.

Under the terms of the Moab Uranium Millsite Transfer Agreement signed by NRC, Utah, and the Atlas Corporation on April 28, 1999, the trustee of a trust to be set up as part of the Atlas bankruptcy settlement, is to be selected by the NRC with the agreement of the designated representative of Utah.

Based on the criteria provided in the NRC's letter to the applicants, the NRC panel individually reviewed the submittals and subsequently met to discuss our evaluations on July 14, 1999, and on August 5, 1999. On both occasions William Sinclair and Loren Morton of the State of Utah's

CONTACT: M. Fliegel, NMSS/URLL
(301) 415-6629

Division of Radiation Control participated by telephone. In the August 5, 1999, meeting, Mr. Sinclair described the criteria that the State of Utah had used to review the submissions which generally reflected the criteria used by the NRC participants, i.e, technical experience and trust experience, but added as a criterion, the State of Utah's past experiences with the applicants.

The participants agreed that the proposals from Dames & Moore and HLA were the strongest submittals. Both organizations had outstanding in-house technical capabilities and extensive uranium recovery and hazardous waste reclamation experience. Based on the technical factors, the participants concluded that both the Dames & Moore and HLA submittals demonstrated the technical expertise to successfully perform the duties of the Trustee. PricewaterhouseCoopers had extensive expertise and experience in administering trusts but lacked strong in-house technical capabilities and experience in uranium recovery reclamation and would have to subcontract most of this work. The other two organizations included: (1) CIMA Energy Corporation, which is a small corporation with more experience with the reclamation of in situ leach fields and very limited trustee experience; and (2) Environmental Technologies, Inc., which has technical experience in the area of groundwater cleanup but did not demonstrate through its submittal that its overall ability to undertake the role of the Trustee for the remediation of the Atlas site was equal to that of either Dames & Moore or HLA.

The NRC participants concluded that the NRC could be comfortable with the choice of either Dames & Moore or HLA as the Atlas trustee, although all NRC participants rated the HLA submittal ahead of that from Dames & Moore. Additionally, the estimated annual administrative costs are comparible, although the startup costs would be higher for Dames & Moore. The State of Utah, however, rated Dames & Moore ahead of HLA. Key factors for Utah's preference of Dames & Moore include Utah's positive experiences in several projects that it contracted out to that organization, that more of the work could be performed by Dames & Moore in-house staff than HLA in-house staff, and that a large part of the Dames & Moore staff is located in Utah, thereby minimizing travel and travel-related expenses. Utah concluded that it felt so strongly about its preference for Dames & Moore, that the State could not concur in the NRC's choice of any of the other organizations.

Based upon the panel's conclusion that both Dames & Moore and HLA would be acceptable choices and on Utah's clear preference for Dames & Moore, the panel recommends that Dames & Moore be selected as the Atlas trustee.

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PROPRIETARY INFORMATION
Not for Public Disclosure

40-3453
X60524

Rogers & Associates Engineering Corporation

Post Office Box 330
Salt Lake City, Utah 84110-0330
(801) 263-1600

April 2, 1993

APR 1993 RECEIVED

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Mr. Ramon Hall
Director, Uranium Recovery Field Office
U.S. Nuclear Regulatory Commission
P.O. box 25325
Denver, CO 80225

Dear Mr. Hall:

As directed by Ms. Dawn Jacobi, we are submitting to you the enclosed copy of QAP-5.8, "Radon Diffusion Coefficient Measurements - Time Dependent Technique/Earthen Materials," for documenting the test procedure used by Rogers & Associates Engineering Corporation (RAE) to measure radon gas diffusion coefficients in soils, uranium tailings, and other earthen materials. This same procedure (previously identified as SQAP-3.6) has been in use for more than 10 years at RAE, and is the basis for the diffusion correlation in NUREG/CR-3533 and NRC Regulatory Guide 3.64.

We are submitting this test procedure to you on a confidential basis conforming to 10 CFR 2.790(b) solely to document the tests done by RAE for its clients. As indicated in the enclosed affidavit, we are requesting that the entire procedure be withheld from public disclosure.

We hope that this will satisfy the present needs under the Canonie Environmental/Atlas Minerals application and potential future needs for documentation. Please contact me if there are any questions or if you need further details.

Sincerely yours,

Kirk K. Nielson

Kirk K. Nielson
Vice President

KKN:csd
enc

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cc: John Gabriele; Canonie
Vern Rogers; RAE

PROPRIETARY INFORMATION
Not for Public Disclosure

Add Info
93-0375 N/I

APPLICATION AND AFFIDAVIT
FOR WITHHOLDING
QAP-5.8 FROM PUBLIC DISCLOSURE

I, Vern C. Rogers, President of Rogers & Associates Engineering Corporation (RAE), hereby apply to withhold from public disclosure the entire document QAP-5.8 entitled, "Radon Diffusion Coefficient Measurements: - Time Dependent Technique/Earthen Materials." This application is made under the provisions of 10 CFR 2.790(b) on the basis that the subject document contains trade secrets and confidential commercial information.

(b)(1)(i) <u>Document to be withheld from public disclosure</u>: QAP-5.8, "Radon Diffusion Coefficient Measurements: - Time Dependent Technique/Earthen Materials," pages 1 through 4 inclusive.
<u>Position of Applicant</u>: President, Rogers & Associates Engineering Corporation.

(b)(1)(ii) <u>Basis for withholding QAP-5.8 from public disclosure</u>

(b)(4)(i) <u>Previous Status</u>: Although the general procedure for RAE radon diffusion tests has been published in U.S. NRC report NUREG/CR-2875 (1982) and U.S. DOE report UMT/0206 (1981), the <u>specific procedures</u> contained in QAP-5.8 have always been protected by RAE from public disclosure. Releases of this information have been limited to the DOE-UMTRA Technical Assistance Contractor's Quality Assurance Office and corresponding entities for auditing and evaluation purposes only. These releases have carried proprietary restrictions.

(ii) <u>Information and Withholding Basis</u>: RAE generally holds all of its laboratory procedures in confidence to protect RAE's competitive position in conducting business. Although a few RAE procedures have been purposely released in scientific publications or governmental disclosure to advance RAE's purposes, QAP-5.8 is not one of them. RAE holds that public disclosure of QAP-5.8 would divulge methods in which RAE has invested many years of research and development including validation, perfection, and documentation of the method. Such disclosure would give competitive ventures the benefits of RAE's investments without compensation to RAE.

(iii) <u>Transmittal of Information</u>: The attached copy of QAP-5.8 is being transmitted in confidence only to the Director of the NRC's Uranium Recovery Field Office for his use in evaluation NRC license applications. It is not being made available to the applicants or their contractors or consultants.

(iv) <u>Public Availability</u>: The detailed information in QAP-5.8 is not available in public sources.

(v) <u>Harm from Public Disclosure</u>: RAE developed the conceptual approach to radon gas diffusion measurement in 1980-1981, and published the general approach at that time (NUREG/CR-2875 and UMT/0206). In every year from 1982 to present, RAE has continued its own private research to refine and perfect the equipment and methods being used and to standardize it to satisfy increasing levels of quality control. RAE has performed thousands of radon diffusion tests commercially with the method, mostly under competitive

contracts with federal, state, and private industrial entities. In some cases sole-source contracts have been awarded because no other method besides the RAE method was judged adequate. Even in competitive procurements, the ability of RAE to respond accurately to test samples has been a deciding factor in contract awards. RAE would lose its unique competitive position for both sole-source and competitive business if competitors have access to its methods.

Date: April 2, 1993

NOTARY: Geraldine R. Wood

NOTARY PUBLIC
GERALDINE R. WOOD
515 East 4500 South
Salt Lake City, Utah 84107
My Commission Expires
October 29, 1993
STATE OF UTAH

THE GREAT SEAL OF THE STATE OF UTAH 1896

Signed: Vern C Rogers

Vern C. Rogers, President
Rogers & Associates Engineering Corp.

UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555-0001
July 10, 1996

40-3453

Mr. Richard Blubaugh
Vice President of Environmental
and Governmental Affairs
Atlas Corporation
370 Seventeenth Street, Suite 3050
Denver, Colorado 80202

SUBJECT: REQUEST FOR WITHHOLDING INFORMATION FROM PUBLIC DISCLOSURE, ATLAS CORPORATION, SOURCE MATERIAL LICENSE SUA-917

Dear Mr. Blubaugh:

By your application and affidavit executed by you on May 14, 1996, Atlas Corporation requested that information on potential sources of rock for riprap be withheld from public disclosure pursuant to 10 CFR 2.790. That affidavit was transmitted by Atlas' letter of May 14, 1996, in which Atlas provided the information on potential sources of rock. The information was provided in response to requests from Nuclear Regulatory Commission staff in its ongoing review of Atlas' proposed reclamation plan for its uranium mill tailings pile at Moab, Utah.

Atlas' affidavit stated that the submitted letter contains sensitive financial information that should be considered exempt from mandatory public disclosure for the following reasons:

- The information contained in the letter has been held in confidence by Atlas.
- Public disclosure of the documents would be detrimental to the interests of Atlas.

We have reviewed your application and the material in accordance with the requirements of 10 CFR 2.790 and, on the basis of your statements, have determined that the submitted information sought to be withheld contains proprietary commercial and/or financial information.

1/1
NU7

Therefore, the information you regard as proprietary will be withheld from public disclosure pursuant to 10 CFR 2.790 (b)(5) and Section 103(b) of the Atomic Energy Act of 1954, as amended.

Withholding from public inspection shall not affect the right, if any, of persons properly and directly concerned to inspect the documents. If the need arises, we may send copies of this information to our consultants working in this area. We will, of course, ensure that the consultants have signed the appropriate agreements for handling proprietary information.

change: NRC PDR LTR 1 Encl. 1NP

N/2

If the basis for withholding this information from public inspection should change in the future such that the information could then be made available for public inspection, you should promptly notify the NRC. You also should understand that the NRC may have cause to review this determination in the future, for example, if the scope of a Freedom of Information Act request includes your information. In all review situations, if the NRC makes a determination adverse to the above, you will be notified in advance of any public disclosure.

If you have any questions regarding this letter, please contact Dr. Myron Fliegel of my staff at (301) 415-6629.

Sincerely,

(Original signed by)

Joseph J. Holonich, Chief
Uranium Recovery Branch
Division of Waste Management
Office of Nuclear Material Safety
and Safeguards

Docket No. 40-3453
Source Material License No. SUA-917

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* see previous concurrence

OFC	URB*	C	OGC*	C	URB					
NAME	MFliegel		MSiemien		JHolonich					
DATE	07/02/96		07/03/96		07/10/96					

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AFFIDAVIT OF RICHARD E. BLUBAUGH

I, RICHARD E. BLUBAUGH, Vice President of Environmental and Governmental Affairs of Atlas Corporation do hereby swear and affirm as follows::

1. That I am directly charged with responsibility for oversight of reclamation of the Atlas uranium mill tailings in Moab, Utah, including responsibility for negotiating, signing and implementing contracts with vendors, contractors and experts involved in the reclamation process. Therefore, I have direct responsibility for identifying rock sources for riprap and for negotiating contracts for the purchase or lease of either the relevant property with appropriate mining rights or the direct purchase of rock from such source(s) of riprap to be used in conjunction with final closure of the uranium mill tailings pile in Moab, Utah;

2. That the privileged and confidential letter dated May 14, 1996 from me to Myron H. Fliegel of the U.S. Nuclear Regulatory Commission that accompanies this affidavit, which specifically identifies potential sources of rock for riprap to be used in the surface reclamation of the Atlas uranium mill tailings pile at Moab, Utah, contains sensitive financial information;

3. The information contained in the above noted letter regarding rock source(s) for riprap to be used in conjunction with the reclamation of the uranium mill tailings pile in Moab, Utah has been held in confidence by Atlas Corporation and its employees including me because publication of the information could lead to complications regarding ownership or control of the property and/or the resource in question, the price to be negotiated for such rock source(s) since a limited number of feasible sources are available, and could potentially subject current owners of

such source(s) to economic or other intimidation by those activists in the Moab community who are opposed to on-site stabilization of the Atlas uranium mill tailings pile;

4. Atlas Corporation has limited financial resources available to perform final closure at the Moab mill tailings site and it would cause substantial harm to Atlas if its efforts to gain access to the necessary rock source(s) identified are burdened by potentially significant cost increases or if such source(s) were to become unavailable, thus forcing Atlas to incur even greater expense to find such source(s) further from the site, as a result of premature disclosure of the source(s) information contained in the above noted letter;

5. Atlas specifically requests that this sensitive financial information be exempted from public disclosure under 10 C.F.R. Part 2.790 as privileged and confidential until contracts or leases have been negotiated and signed for such rock source(s) whereafter it would no longer be necessary for NRC to maintain this information as privileged and confidential.

ATLAS CORPORATION

BY: Richard E. Blubaugh

RICHARD E. BLUBAUGH
Vice President-Environmental and Governmental Affairs

Subscribed and sworn to before me this 14th day of MAY, 1996.

MY COMMISSION EXPIRES:

Carl Dixon
NOTARY PUBLIC

CARL DIXON
NOTARY PUBLIC • STATE of UTAH
1521 SPANISH VALLEY DR.
MOAB, UT 84532
COMM. EXP. 7-31-96