accepted criteria for the management of roads, such as the Manual on Uniform Traffic Control Devices and publications, standards and specifications of the American Association of State Highway and Transportation Officials (AASHTO), Washington State Association of Counties, WSDOT and WUTC.

XI. WATER QUALITY IMPACTS AND MANAGEMENT

A. Water Quality Impacts (Excluding Surge Pond)

1. Leachates

   a. Water Power, the Department of Ecology (WDOE) and the Council have recognized that the proposed project may potentially degrade ground water and surface water quality.

   b. The primary sources of potential degradation are leachates from disposed bottom ash, fly ash, FGD (Flue Gas Desulfurization) sludge and the 90-day coal storage pile. Potential contaminants and pollutants cannot be precisely identified until a coal source is selected.

   c. Solid and liquid wastes from the site may fall into the "dangerous wastes" category under WDOE regulations signed in February, 1982, and effective on March 12, 1982. (TR Vol. 27, p. 4325, Knudson)

   d. Based upon the record, detrimental effects upon flora and fauna are not expected. However, there is still the potential that some such effects could occur.

   e. Contamination of local aquifers would degrade the quality of waters used for domestic, stock and irrigation purposes.

2. Surface Water

   a. The project will significantly modify the natural drainage patterns at the site. Because of the construction of various on-site ponds, the total run-off to Sinking Creek will be reduced by about 3% at the beginning of the project. Run-off will then increase, over the 35-year span of the landfill operation, to a maximum of about 15% over current levels. As a consequence of runoff and recharge from the surge pond, Sinking Creek will likely develop a perennial flow. However, increasing the flow

of Sinking Creek will not, in itself, lower the quality of the water.

b. Of the 39 ponds and wetlands in or near the plant area, 18 ponds will not be affected; 14 will be affected and seven may or may not be affected, depending on the exact location of the drainage ditches. The 18 unaffected ponds represent more than 50 percent of the total pond surface area on the site. (TR Vol. 12, p. 1863; App. 5.2.4)

c. Construction of the well site, makeup water pipeline and associated electrical transmission facilities will temporarily increase local turbidity. Due to use of containment structures, no increased turbidity is anticipated for local streams from construction of the plant and landfill. The record does not indicate that significant environmental impacts will result from any changes in turbidity.

d. Some substances contained in the air emissions from the CGS may enter into surface waters at the CGS site and surrounding areas. The principal source of such substances is the deposition of salt from the cooling towers. The anticipated impacts are not environmentally significant.

3. Ground Water

a. There is no evidence of hydraulic continuity between the well field location and the local aquifers. (TR Vol. 12, p. 1906, Loo) No adverse impacts on the pumping of water for local use are anticipated from operation of the well field.

b. There is evidence of variability of aquifer characteristics in the area. The shallow aquifers have hydraulic continuity with Sinking Creek and there is potential for carrying contamination there.

c. Water Power's ground water measurements are preliminary and final conclusions on aquifer characteristics will await further study.

B. Water Quality Mitigations (Excluding Surge Pond)

1. Preliminary Findings

a. It is reasonable and prudent that the proposed project, as a condition of certification, meet all standards of RCW 90.48, which forbids the pollution of any receiving waters in the State.

b. The Applicant does not expect ground water to be degraded by leachates from the ash and sludge disposal areas or the coal storage pile. However, it may be less expensive to line these areas before operation, than to bear the costs of restoring ground waters to baseline quality and lining these areas after operations have begun, if degradation does occur. (TR Vol. 26, p. 4182 and TR Vol. 27, p. 4238, Wildrick)

c. The coal pile will be compacted which will discourage percolation.

d. Water Power proposes not to line either the coal pile, the solid waste storage areas or the run-off drainage ditches. It maintains that leaching from these areas is unlikely to occur and, if present, will be subject to rapid detection and mitigation. The record supports this position from a preliminary standpoint only. Further confirming studies will be required. The Applicant has agreed to perform studies of this nature. The parameters of such studies are appropriate conditions of site certification. If such studies do not confirm Applicant's preliminary position, lining of any or all of the above-referenced areas may be required. (TR Vol. 32, p. 4530, Loo)

e. The timing of the above-referenced studies will be a crucial condition of certification. The record shows that monitoring of a test pile of the chosen coal may be required to gauge leachate probability and character. (TR Vol. 27, p. 4263,Burkhalter) The establishment of necessary data on aquifer recharge rates is likely to take as long as one year. (TR Vol. 26, p. 4177, Wildrick)

2. Commitments to Lining

a. Water Power has committed to lining with impervious liners, the various liquid waste storage ponds where contaminants will be known to occur. These include the waste water evaporation pond, the sanitary waste stabilization pond and the water retention ponds. This is a prudent measure for the protection of water quality.

b. It is a reasonable condition of certification that the runoff ditches leading to the ponds be lined as well.

3. Solid Wastes

a. The Applicant proposes to combine the FGD sludge, fly ash and bottom ash; to treat this combination with a fixating reagent; and to dispose of it by compacting it in a dry landfill. This process is known commercially as the "pozzolanic process" and is offered in lieu of lining. It will lessen the risk of ground water contamination from the areas where these materials are stored. (TR Vol. 4, pp. 542, 543 and 548; Vol. 5, pp. 622-623, Normoyle; Vol. 5, p. 565, Falkenberg; Vol. 27, p. 4350, Burkhalter)

b. Alternative methods of solid waste disposal have been considered including ponding in lined areas, shipment of ash back to the coal mine, and sale of fly ash and bottom ash to available markets.

c. Lining of solid waste areas is unnecessary at this time because the process of fixating fly ash, bottom ash and FGD sludge will provide a relatively impervious barrier to leachates. Shipment of ash back to the mine is not a reasonable alternative for a variety of practical, legal, and monetary considerations. Water Power will actively promote the sale of fly ash and bottom ash to existing markets. (TR Vol. 5, p. 547, Normoyle)

d. Water Power will use portable toilets for sanitary wastes at the construction site until sanitary waste systems are installed.

4. Dam Safety

It is estimated that the site will contain approximately nine impoundments most of which will have the capacity of retaining volumes of 10-acre feet or more of water. It is a reasonable condition of certification that all such structures be designed to safely withstand 100-year frequency flood events. The level of design should be based upon the degree of hazard to life and property that exists in the floodplains below these structures. It is an appropriate condition of site certification that all structures comply with state law, WDOE regulations and safety requirements.

C. Surge Pond

1. The storage of water in the makeup water surge pond will recharge shallow aquifers and is likely to create perennial flow in the Sinking Creek drainage southwest of the surge pond location.

2. Water Power proposes to introduce 700 pounds of copper sulfate yearly into the surge pond to control algae. Copper sulfate will precipitate as copper hydroxide. (TR Vol. 12, pp. 1879-1881, Mayer) The copper hydroxide will not dissipate, but will accumulate at the bottom of the pond. Although other means of controlling algae are available, copper sulfate was chosen for its cost-effectiveness and ease of handling. Trace amounts of copper will leave the surge pond as ground water flow.

3. Water Power has estimated surge pond seepage at a rate of six cubic feet per second (cfs). (TR Vol. 12, p. 1885, Anderson) Depending on how the pond is constructed, the rate could vary considerably. Seepage at 6 cfs represents a loss of 15-20% of the total pumpage from FDR Lake. There is ascertainable economic value assigned to pumpage from FDR Lake. (TR Vol. 12, p. 1883, Normoyle) It is not known how much of the surge pond seepage will emerge as surface flow. (TR Vol. 12, p. 1917, Anderson) If the rate of leachate is high enough, copper may be carried from the surge pond into Sinking Creek via the aquifer. (TR Vol. 26, p. 4214, Burkhalter)

4. Water Power does not propose to line the surge pond to prevent leakage. The decision not to line is based on Water Power's perception that the risk of negative impacts from leakage is too low to justify the costs of lining. The record supports the position that the risk is low. However, if substantial leakage did occur, the release of copper compounds could be environmentally harmful. (TR Vol. 26, p. 4214, Burkhalter)

5. Water Power proposes to monitor groundwater impacts and take mitigating measures, if necessary. It has not yet established a water level monitoring program. A year or more of monitoring will be necessary to determine the quantity and rate of precipitation infiltration to the aquifer. Establishing the recharge rate will improve the predictions of leachate infiltration to the aquifer.

6. Additional information is needed on the precise probability and character of leachates from the surge pond. Further studies, within specific parameters, are appropriate conditions of site certification. Such studies could be incorporated into the testing program the Applicant has proposed. (TR Vol. 12, p. 2017A, Berthrong) Timing of such studies should be planned to substantially precede any potential negative effects of leachate. Should the studies support the Applicant's position that lining is unnecessary, only monitoring of leachate effects will be required as a condition of site certification.

D. Potable Water

Water Power has stipulated with the Washington Department of Social and Health Services (Exhibit 106) that installations supplying potable water to the CGS during construction and operation will conform with standards and regulations of DSHS.

XII. AIR QUALITY

A. Introduction

1. General

a. In Section IV.C. of these Findings, the existing air quality in the Creston area and the methodology used by the Applicant to predict the effects of CGS construction and operation on air quality are described. This section discusses air quality degradation which will result from construction and operation of the CGS and the methods used to mitigate adverse effects.

b. In balancing ecological and energy concerns, these findings: (1) identify the effects of various airborne pollutants upon the environment; (2) consider control technologies which are reasonably available; and (3) determine the levels and methods of control necessary to reduce pollutants to acceptable levels considering the environment, energy and cost.

c. CGS stack emissions will include various pollutants regulated by the Federal Clean Air Act. These include carbon monoxide (CO), nitrogen oxides (NO_x), sulfur dioxide (SO_2), particulate matter (PM), ozone, lead, beryllium, mercury, vinyl chloride, fluorides, sulfuric acid mist, total reduced sulfur, reduced sulfur compounds, and hydrogen sulfide. The record shows that asbestos, vinyl chloride, total reduced sulfur, reduced sulfur compounds and hydrogen sulfide will be emitted in negligible quantities.

d. Of particular concern are SO_2, NO_x and particulates. (DEIS D-47) (Ex. 45, p. 6-54) The three major variables which determine the impacts of these pollutants are concentration, duration, and frequency. A high concentration encountered over a short period of time may result in harm equal to that of lesser concentrations encountered over a longer period of time. (Ex. 45, p. 6-54)

2. Crops

a. Lincoln County is the second largest wheat-producing county in the state. 670,000 acres, some 45% of the land area of the county, are devoted to dryland farming of winter wheat. Of this total acreage, half is devoted to wheat production and half to summer fallow each year. Other dryland crops are spring barley, pasture grasses, hay, spring wheat, grasses and legumes for soil improvement, and various small grains. 50,178 acres are devoted to irrigated crops. The bulk of this irrigated land is in winter wheat. Hay, peas, spring wheat, beans and grass and alfalfa seed are other irrigated crops. There are 125 acres of orchard production in the county.

b. Summer fallow in alternate years is a practice adopted to allow the soil to collect additional moisture for the next year of wheat production. Winter wheat is seeded early in September and harvested the following August. Wheat plants are dormant, or nearly so, during the months of December, January, February and March. Though the crowns, roots and leaves of the plants are alive, there is little metabolic activity taking place at those times.

c. The average dryland wheat yield in Lincoln County was 50.7 bushels per acre in 1980, with a range of about 25-60 bushels per acre per crop year on individual farms. The average price per bushel in 1981-1982 was $4. (TR Vol. 45, p. 7161, Michalson; Ex. 171)

d. Major wheat diseases in Lincoln County are stripe rust, foot rot, dwarf bunt, take-all, yellow dwarf virus and snow mold. Bunt infections are controlled by seed treatment and the use of resistant varieties. The major insect problems arise from infestation by wireworms and aphids. Infestations are treated with insecticides. Winter injury occurs due to low winter

temperatures or frost damage at critical growth stages. Infection by disease organisms can result in clogging the water-conducting vessels of the plant stem, reducing water supply to the leaf, resulting in an effect closely resembling the consequences of drought.

e. At the onset of conditions which produce moisture stress, the wheat plant reacts in a manner which has the effect of reducing moisture loss. Its primary method of moisture conservation is to close the stomata, tiny pores in the leaf surface through which moisture vapor normally is transpired. Transpiration in turn activates a flow of moisture and nutrients from the roots to the leaves. Normally, a significant reduction in water use efficiency can result in yield loss under dryland farming conditions such as exist in Lincoln County. (TR Vol. 44, p. 7053, George)

f. The growth stage of winter wheat is an important factor in its relative sensitivity to air pollutants. Wheat tends to be resistant to SO_2 pollution up to the two-leaf stage of development and becomes most susceptible shortly thereafter, at about the three-leaf stage. This phase of special susceptibility generally occurs in October. The plant is again particularly susceptible in the boot stage which may occur from mid-February to early July, most commonly beginning in June. Some studies suggest that grasses in general are more susceptible to SO_2 damage in the winter months when growth is slow. The most resistant period to SO_2 pollution for winter wheat is, therefore, from harvest in August to October.

3. CRSTER Modelling

a. The Applicant utilized computer modelling to predict concentrations of SO_2 from the plant emissions. For Lincoln County and other agricultural areas, which are in level to

rolling terrain south of the Spokane River and FDR Lake, principal reliance was placed upon the CRSTER atmospheric dispersion model. CRSTER is a steady-state Gaussian plume dispersion model developed by EPA. It was designed to predict maximum and maximum second-highest pollutant concentrations for both short-term (one-hour, three-hour, 24-hour) and long-term (annual) time periods due to emissions from isolated point sources. CRSTER is EPA's preferred technique for assessing power plant air quality effects, for terrain similar to the CGS site.

b. The computer was programmed for maximum SO_2 emissions, assuming four units operating for 24 hours each day, firing the highest sulfur coal, coal D, with a sulfur content of .843 pounds per million Btu (lb/mmbtu), and without chemical alteration or loss of the emission pollutants between point source and receptors. Meteorological inputs included hour-by-hour surface data and mixing heights from Spokane International Airport (1973-77) and data from the Applicant's on-site monitoring program (1980 and 1981).

c. Concentration levels were predicted each hour for a period of 366 days at 720 ground-level receptor sites from one kilometer to 100 kilometers from the plant site. Concentrations were predicted in a radial grid 360° around the plant site.

d. The resulting hourly concentrations for each receptor site provided the foundation for the Applicant's air quality analysis. From this basis, CRSTER demonstrated low concentration regimes. The maximum annual average concentration of SO_2 from plant emissions at any receptor is projected to be .001 parts per million (ppm), far below any threshold of effect suggested by the literature of SO_2 effects on plants. Concentrations were predicted to be below detectable levels, close to zero, in over 98% of the hourly predictions made by CRSTER.

e. Based upon the CRSTER results, the maximum and maximum second-highest SO_2 impacts from CGS emissions at any receptor, in level to rolling terrain, over the seven year period modelled were predicted to be:

	Maximum SO_2	Maximum Second-Highest SO_2
Annual	*2.9 ug/m^3 (0.001 ppm)	----------
24-hour	62.8 ug/m^3 (0.024 ppm)	48.5 ug/m^3 (0.019 ppm)
8-hour	162.5 ug/m^3 (0.062 ppm)	131.9 ug/m^3 (0.050 ppm)
3-hour	259.1 ug/m^3 (0.099 ppm)	231.3 ug/m^3 (0.088 ppm)
1-hour	404.1 ug/m^3 (0.154 ppm)	364.6 ug/m^3 (0.139 ppm)

(* ug/m^3 = micrograms per cubic meter)

Comparable figures for earlier CRSTER runs, using Spokane Airport meteorological inputs, are set out in Table 6.2-1 of the Applicant's PSD Application.

f. CRSTER did not model NO_2 emissions, though a basis for a calculation was provided. Corresponding maximum NO_x concentrations can be determined by multiplying predicted SO_2 concentrations in ug/m^3 by 2.77 and ppm values by 3.86. The Applicant used the conservative assumption that 100% of NO_x would be emitted as NO_2. It is more likely that 70% of the NO_x emissions will be in the form of NO_2 after reaction of NO_x with oxides in the environment. Based on the 70% assumption, maximum and maximum second-highest concentrations for NO_2 are the following:

	Maximum NO_2	Maximum Second-Highest NO_2
Annual	5.6 ug/m^3 (.003 ppm)	----------
24-hour	121.8 ug/m^3 (.065 ppm)	94 ug/m^3 (.051 ppm)
8-hour	315.3 ug/m^3 (.167 ppm)	255.9 ug/m^3 (.135 ppm)
3-hour	502.7 ug/m^3 (.267 ppm)	448.7 ug/m^3 (.238 ppm)
1-hour	784 ug/m^3 (.416 ppm)	707.3 ug/m^3 (.375 ppm)

g. Using an assumed emission rate of 4,560 pounds per hour of SO_2 for all four units, the computer was programmed for each hour of the CRSTER Model runs. Adjustments to concentrations as a consequence of a different emission rate can be made by the direct mathematical relation of the emission rate studied to the base of 4,560 pounds per hour of SO_2.

h. The Applicant has proposed an emission limit of 4,560 pounds per hour on a 24-hour rolling average. Water Power has, however, requested a one-hour per unit maximum SO_2 limitation of 2,764 pounds of SO_2. The draft Site Certification Agreement approved by the Council on May 24, 1982, limited sulfur dioxide emissions to 1,250 pounds per hour per unit on a 24-hour rolling average basis and 2,500 pounds per hour per unit on a one-hour average basis not to be exceeded more than once during any calendar month. Even at the 2,500 pounds per hour figure, there remains some potential for four units to emit up to 10,000 pounds per hour of SO_2 for one or more hours, provided the 24-hour rolling average for the units is not exceeded. Under the Applicant's proposal of 2,764 pounds per hour, four units might emit 11,056 pounds per hour in some hours, 242% more than the 4,560 pounds per hour programmed into each hour of emissions predicted by CRSTER. To consider the concentrations resulting from such a hypothetical instance, one need only multiply the CRSTER-predicted concentrations by a factor of 2.4. In this way, CRSTER can be used to consider maximum potential exposure regimes which might occur within proposed permit conditions. For instance, the predicted maximum one-hour incident of SO_2 fumigation may be presumed to change from 404.1 ug/m^3 (0.154 ppm) to 969.84 ug/m^3 (0.36 ppm). Although it is theoretically possible that the 4,560 pounds per hour SO_2 limitation could be doubled in a single hour under the original draft Site Certification Agreement (TR Vol. 48, p. 7657, Paulus), such an event would be extremely unlikely. (TR Vol. 48, pp. 7649, 7656, Paulus)

i. The reliability of CRSTER, particularly for its applications in this hearing has been questioned by Blue Sky Advocates. Dr. Michael Williams described many aspects of CRSTER's design which caused it to deviate from the future reality it was attempting to predict. There was considerable dispute over the conclusions of several studies done by EPA designed to check CRSTER predictions against real events, to, in short, validate its products. Dr. Michael Williams concluded that CRSTER probably underestimated most of the predicted CGS concentrations by a factor of five. He referred to the validation studies to support his criticisms. The studies showed a reasonable level of accuracy for highest and second-highest hourly SO_2 concentrations. Dr. Michael Williams granted CRSTER was reliable for these high concentrations within a plus or minus range of 10 to 40% accuracy. He utilized charts comparing predicted with measured and measured minus background concentrations to support his proposed 500% increase in SO_2 predictions at lower concentrations. The effective cross-examination of this testimony and the studies themselves (Ex. 129, 130, 176) emphasized the admittedly subjective element in Dr. Michael Williams's choice of the factor of five as a multiplier.

j. The testing of this evidence did not, however, establish that EPA's attempts to validate CRSTER for lower concentrations had succeeded. Mr. Paulus admits that the validation studies neither validate nor invalidate those CRSTER-predicted concentrations below the highest and second-highest hourly SO_2 concentrations. Stated another way, EPA attempted to validate CRSTER's use for such purposes on three occasions and could not do it. In each validation study, CRSTER was, however, shown to consistently underpredict lower concentrations, those below maximum highest and second-highest. Under these circumstances, it is not possible to make any meaningful description of CRSTER in terms of confidence intervals or

statistical accuracy for predictions of these lower concentrations and the frequency of their occurrence.

k. EPA developed CRSTER to identify short-term high levels of concentration, maximum and maximum second-highest concentrations for different time intervals. This goal of CRSTER is reasonable. The literature concerning effects on plants causes more concern for high concentration incidents than long-term chronic concentrations. Concern for short-term high concentrations is central to the testimony of the Applicant's experts, Dr. Kohut and Dr. Lefohn.

l. CRSTER assumes the recurrence of meteorological events that have occurred in the past. It is highly unlikely, for instance, that SO_2 fumigation incidents predicted to occur at a particular time and place will actually occur at that time and place.

m. CRSTER did not model inversion breakup fumigation. This phenomenon may occur when an emission plume flows into a stable atmosphere and is transported downwind as a compact flat ribbon. As the air warms, mixing develops from the ground level up to the plume and the plume can be rapidly mixed to the ground. This can result in high, short-term (30-45 minute duration) concentrations within a relatively narrow band beneath the original stable plume. By a series of complex methods and calculations, the Applicant predicted a maximum one-hour concentration 16 kilometers from the plant site of .164 to .177 ppm SO_2. Another method of calculation predicted a somewhat lower concentration. Inversion breakup fumigation, leading to high concentrations at various distances from the source, will occur infrequently. It is unlikely that this event could cause high concentrations to fall in the same place more than once.

n. The Applicant has utilized CRSTER results as an essential element of its air quality analysis. The concentration regimes reported have been compared with the literature on plant response to SO_2. Various threshold levels of "injury", "damage", or "adverse effect on yield" have been extrapolated from the studies. CRSTER concentrations have been compared to threshold concentrations leading to the Applicant's conclusion that there will be no demonstrable adverse effects on vegetation from CGS emissions. CRSTER is an important, if not essential, part of this analysis. The potential for wide variations between predicted and measured concentrations exists, particularly for those concentrations below those predicted as highest and second-highest maximums.

B. Potential Impacts of CGS Emissions

1. Potential Impacts - General

a. Construction and operation of the CGS will result in increased fugitive dust and carbon monoxide (CO) levels. These are emissions which do not come from the plant itself, but from construction, traffic, material storage and handling, and train delivery of coal. Sources and levels of these particulate emissions are listed in Exhibit 45, Table 3.2-13. This listing describes the sources and levels which may be expected to occur.

b. Both the stacks from the combustion process and the cooling towers will have visible plumes under certain conditions. The visibility of the cooling tower plume is expected to be greater due to the high moisture content of the emissions. In predicted worst-case conditions, occurring approximately 0.4% of the time, cooling tower plumes extending for 7 to 8 miles are expected. This will probably occur during days of high relative humidity which are generally associated with overcast or rainy conditions. (Exhibit 45, pp. 6-44, 6-45) Extended visible plumes

from the combustion stacks will occur less frequently and will be substantially smaller in size.

c. Combustion stack emissions will usually be invisible due to particulate control devices. However, NO_x stack emissions could convert to NO_2 under certain circumstances resulting in a reddish-brown plume discoloration. (Exhibit 45, pp 6-45) Modelling results indicate that on very infrequent occasions a reduction in visibility from 5-10% could occur when the plume would be visible as a reddish-brown discoloration to an observer looking through the plume. (Exhibit 45, pp. 6-47, 6-52) Plumes will have no significant visibility impact upon existing Prevention of Significant Deterioration (PSD) Class I areas nor on integral vistas associated with National Parks. (Exhibit 45, pp. 6-42, 6-52).

d. The plant in operation will not cause any significant misting, fogging or icing. Such extremely low levels as might occur under certain conditions will rarely extend beyond plant site boundaries. (DEIS, Section 3-10, 3-11)

e. Construction and operation will also involve refuse disposal and waste burning. In performing these activities, the Applicant will be required to comply with all local, state and federal regulations and guidelines, as required in the Site Certification Agreement.

f. Operation of vehicles and fuel burning equipment will result in exhaust emissions and possible emissions from hauled materials blowing away. The most reasonable methods for controlling these emissions are: ensuring that all vehicles and fuel-burning equipment are kept in proper mechanical order; and requiring vehicles hauling materials to be covered where those materials are likely to be blown away when hauled. These requirements should be stated in the Site Certification Agreement.

g. Fugitive dust will occur during site preparation and construction. Traffic, clearing, grading and excavation will result in increased fugitive dust levels. The most reasonable methods for controlling these emissions are watering, paving, controlling the speed of vehicles and chemical treatment. Conditions necessary to mitigate these emissions should be contained in the Site Certification Agreement.

h. The presence of salts and dissolved minerals in the cooling tower emissions is another concern. Some salt build-up can be expected in the area surrounding the plant as the land is irrigated and the water evaporates. Because salt drift from the cooling towers will be concentrated within one mile of the towers, the vast majority of salt will be deposited within the boundaries of the plant site. These depositions will increase the dissolved salt load in site rainwater runoff. If runoff is properly controlled, no significant adverse environmental impact is likely to occur.

i. Under certain rare meteorological conditions, such as inversion breakup fumigation, concentrations of SO_2 and NO_x may give rise to a perceptible odor of sulfur. These conditions will be rare and normally the odor will not be perceptible off the plant site. (DEIS 3-22, TR Vol. 28, p. 4487) Therefore, odor will not present a significant adverse environmental impact.

j. Operation of the CGS will release radionuclides in very small amounts. This results from the fact that coal contains trace amounts of radioactive isotopes of uranium, thorium, radon, radium, lead, polonium and bismuth. These releases are at levels below any threat to health. The vast majority of these trace amounts will be removed by the particulate controls to be used at the plant. With the exception of Radon-222, which is a gas, these materials will be collected in the fly or bottom ash.

The Applicant has entered into an agreement with the Washington State Department of Social and Health Sevices dated December 10, 1981, which deals with monitoring these materials. The conditions of that agreement are reasonable and provide adequate and appropriate protection for the public and the environment. The conditions of the agreement are appropriate for incorporation into the Site Certification Agreement regarding the CGS.

k. Sulfuric acid mist is a by-product of the combustion and flue gas desulfurization (FGD) processes. Any such emissions are not expected to be carried beyond the plant boundary or to occur in harmful concentration.

2. Potential Effects of SO_2 on Crops

a. Lengthy portions of the air quality hearing record are devoted to expert testimony and scientific studies concerning the effects of SO_2 on plants. Drs. Kohut, Wayne Williams and Lefohn, as well as Professor George, have researched the literature on this subject. These experts have approached the subject from differing perspectives and have reached varying conclusions. It is a challenging task to take from this complex and confusing body of information, knowledge which can be applied to the issues raised by this Application.

b. There is no question that sulfur dioxide in sufficiently high concentrations is harmful to plants. Plants exposed to very high concentrations of SO_2 will die. Properly-controlled SO_2 emissions from the CGS will be far below identified acute toxic levels, however, and the real issues raised by this Application lead to assessment of sublethal concentrations of SO_2. Several questions become immediately pertinent. How much SO_2 is too much? How long an exposure is too long? How many exposures are too many? The first question relates to concentration, the second to duration and the third to frequency.

c. Assessment of these questions is complicated by the fact that there is no scientific information specific to Lincoln County or the cultivars grown there. Experts have had to resort to analysis of data produced in other circumstances, much of it widely varying, and make largely subjective extrapolations to the Lincoln County situation.

d. The spectrum of plant responses to SO_2 is wide. Responses may include:

1) no effect;
2) increased growth or yield;
3) visible injury with or without growth or yield reductions;
4) growth or yield reductions with no apparent visible injury; and
5) plant death.

e. The specific response of a plant to SO_2 will be affected by other variables. Some examples are:

1) the species or variety of the plant studied;
2) climate and meteorological conditions;
3) the growth rate and stage of development of the plant;
4) moisture availability;
5) heat;
6) light;
7) the presence of other air pollutants;
8) soil conditions;
9) agricultural practices; and
10) pre-existing stress (disease, infestation, drought, freezing).

f. Scientists studying plant responses to SO_2 have attempted to develop dose-response curves. This effort is continuing at this time. This work aims to develop predictions of crop losses based on a mathematical relationship between pollutant dose

and yield reduction. Dose is a function of concentration over time. If such a relationship could be established, it would allow predictions of yield reduction, given the concentration, duration and frequency of exposure to SO_2. The Environmental Protection Agency has concluded that a valid dose-response curve is beyond the state-of-the-art at this time.

g. Dr. Wayne Williams appeared as a witness for Blue Sky Advocates. Dr. Wayne Williams asserted he could predict yield loss as a consequence of CGS emissions. Moreover, Dr. Wayne Williams suggested yield losses might approach 20%, being certainly at least 3%, at selected locations downwind from the CGS. His testimony on dose-response curves is not considered credible and is of no assistance to this Council. It is fatally flawed for the following reasons:

1) He essentially assumed that SO_2 and NO_x were equally toxic when they are not. This assertion was supported by a distorted analysis of the confusing and contradictory subject of SO_2 plus NO_2 synergism. From these studies, he concluded that synergism meant one could double the toxicity of the most toxic participant in the synergistic reaction ($SO_2 + NO_2 = SO_2 \times 2$).

2) After combining SO_2 and NO_2 and assuming all was SO_2, he identified an inflated estimate of the number of fumigation incidents exceeding concentrations of .01 ppm SO_2 for one hour.

3) He then totalled the number of $SO_2 + NO_2$ hours. In this fashion, he effectively ignored the factors of exposure frequency and potential for plants to recover during lengthy ensuing periods of high air quality. Dr. Wayne Williams essentially stated plants accumulate SO_2 and do not recover from its effects.

4) He derived concentration and duration numbers for placement on his curves from various studies. Examination of those studies revealed, in many instances, that the authors would not endorse Dr. Wayne Williams's characterization of the products of their research, i.e., the numbers were taken out of the context in which they were developed.

5) He did not use all data points available for the development of his curves and his selections implied a bias toward over-prediction of yield reduction.

6) He used data relating to foliar damage, yield loss, and total biomass decrease as if they described the same response, again totally disregarding the prospect of recovery.

7) He made mathematical errors on essential equations and produced equations which could not reproduce his conclusions.

8) After adjusting his curve in response to criticism, he was unable to verify the statistical accuracy of his process due to lack of knowledge about statistical validation processes.

h. Dr. Wayne Williams was a patient and cooperative witness. He is obviously sensitive to the environment and his motives are not criticized by these findings. However, given the atmosphere of doubt, anxiety and strained trust which has come to exist between the Applicant and Lincoln County farmers, Dr. Wayne Williams's participation in this process must be viewed as unfortunate. The record of this proceeding establishes that energy facility licensing is a poor sea for shake-down cruises of unrefined scientific theories.

i. Work continues by qualified experts leading to the development of dose-response curves. If such curves could be developed within some estimated confidence parameter, they would no doubt assist a body such as this Council. The National Crop Loss Assessment Network (NCLAN) is attempting to develop dose-response curves with a strong economic impact component. NCLAN is looking to results from this work to be produced in 1985. Wheat is one of the crops NCLAN is studying.

j. The subject of potential interaction of pollutants has been examined. The effects resulting from pollutant interaction may be:

1) antagonistic, or less than the sum of the effects produced by each pollutant individually;

2) additive, or equal to the sum of the effects produced by each pollutant individually; or

3) synergistic, or greater than the sum of the effects produced by each pollutant individually.

k. Blue Sky Advocates has urged the proposition that concentrations of SO_2 and NO_2, when combined, act synergistically to produce detrimental plant responses at concentration levels below those at which either pollutant would produce such a response, acting individually.

l. The Applicant, by Dr. Kohut, suggested, in testimony before the Council, that it should consider the combined effect of SO_2 and NO_2 to be only additive, no more than the sum of the individual effects of each. Dr. Kohut goes further and states that concentrations of NO_2 produced by CGS would not cause a detrimental response. He therefore suggests any contribution of NO_2 to toxicity can be ignored.

m. The positions of both parties are drawn from the scientific literature. The research involved on the subject of synergistic reactions of SO_2 and NO_2 has been extremely fragmentary and has produced inconsistent results. The scientific references on this subject are summarized below:

1) Ashenden, 1979, Exhibit 163--0.11 ppm of SO_2 and NO_2 were applied, separately and in combination, to cocksfoot and meadow grass for 103.5 continuous hours per week for 20 weeks. Some effects were synergistic.

2) White et. al., 1974, Exhibit 195--.25 ppm of SO_2 and NO_2 were applied to alfalfa in one and two hour fumigations and a greater depression of photosynthesis occurred than if either were applied individually. The same result occurred at levels of .15 ppm. However, the degree of synergism decreased as concentrations increased.

3) Tingey et. al., 1971, Exhibit 193--Various plants, including oats, were exposed for four hours to combinations of SO_2 and NO_2 ranging from .05 ppm to .25 ppm. The resultant plant injury was synergistic but decreased as concentration increased.

4) Ashenden and Williams, 1980, Exhibit 199--Ryegrass and timothy grass were exposed to .06 to .08 ppm SO_2 and NO_2 for 103 hours per week. Synergistic effects were noted. The authors noted that grasses appear more susceptible to aerial pollutants during winter months.

5) Bennett et. al., 1975, Exhibit 203--Several plant species were exposed to concentrations ranging from .125 ppm to 1 ppm of SO_2 and NO_2. Species other than radish, including oats, showed only a slight tendency for synergistic effects.

n. There is a tendency for synergistic effects of SO_2 and NO_2 to be found at lower concentrations below the threshold for effects from either pollutant acting independently. In this fashion, the concept of synergism tends to complicate conclusions that short-term breaches of injury thresholds by CGS emissions are rendered unimportant by the infrequency of such incidents. Dr. Kohut's assumption of only additive effects occurring between SO_2 and NO_2 may be too conservative. There is a possibility that synergism of SO_2 and NO_2 may aggravate the potentially toxic relation of these pollutants to plants in Lincoln County.

o. Reference has been made to threshold levels of SO_2. The concept of threshold has been a complex and confusing element in this proceeding. The Applicant asserts that there will be no demonstrable adverse effects to crops in Lincoln County from CGS emissions. This conclusion has been reached with reference to a threshold of harm. A threshold in this proceeding has come to mean a concentration of SO_2 for some duration below which there are no identifiable adverse effects. Stated another way, a threshold may be that concentration of SO_2 for some duration above which some identifiable consequence occurs which can be characterized as adverse. This process becomes complex in a variety of ways. What is adverse? Blue Sky Advocates asserts it is adverse for a plant to open its stomata when the environmental setting alone would not elicit that response. The Applicant has inclined its thresholds more toward concentrations which can be said to have a demonstrated yield effect . In this fashion, the record is replete with references to "the threshold level of plant response to SO_2," "the threshold for injury to the plant," "the threshold of yield effect," and "the visible injury threshold." A threshold level is some stated concentration of SO_2 for some duration. The durations vary widely, from one hour concentrations to seasonal

concentration regimes. As a consequence, it is difficult to compare threshold levels for "yield," to take an example, from one duration to another, or from one plant species to another.

p. The concept of a threshold yield effect, especially for wheat, is highly controversial. Where visible leaf injury may produce a direct yield loss capable of reasonable estimation for a crop like tobacco, visible leaf injury to wheat cannot be reasonably related to reduction in yield. Heggested and Heck (1971, Exhibit 179) reviewed the literature and determined that SO_2 concentrations of .05 to 1.0 ppm SO_2 for eight hours were necessary to produce injury to sensitive plant species.

There is an additional element of subjective judgement involved in determining which plants are sensitive or resistant. Wheat would seem to be moderately resistant, recognizing that environmental factors, differences in cultivars and growth stages might modify this classification.

q. The eight-hour maximum SO_2 concentration predicted by CRSTER of .062 ppm SO_2 is greater than the .05 ppm SO_2 lower end of the Heggested and Heck (1971) threshold for injury to sensitive plants. Dr. Kohut and Dr. Lefohn both endorsed the concept of .1 ppm SO_2 as a one hour threshold for yield effect to wheat. This threshold would be exceeded by CRSTER's predicted one-hour maximum concentration and is closely approached by the three-hour maximum highest concentration .099 ppm. When Dr. Lefohn was presented with a hypothetical worst case of four hours of concentrations at or above .1 ppm SO_2, he stated he would expect no yield effect. Further, he would expect no injury or any adverse effect. He clarified his description of .1 ppm SO_2 as a one-hour yield effect threshold for wheat by stating he really intended that threshold to be a point at which the scientist "might be concerned," or would

"take a closer look." He emphasized the high air quality of the days and weeks which would precede and follow the four-hour hypothetical fumigation. In effect, Dr. Lefohn comes very close to saying only acute toxic concentrations would produce concern where, as here, long periods of barely measurable concentrations of SO_2 will give plants an opportunity to recover. This post-threshold analysis contradicts, rather than clarifies, his earlier testimony on the yield threshold for wheat. The analysis further disregards the potential for subtle effects in which growth and yield reductions occur without evident foliar injury. These effects are microscopic and molecular and are not readily identifiable. They include metabolic and physiological changes which may subsequently produce alterations in growth and yield. (Appendix C, Exhibit 179)

r. The primary route of uptake of air pollutants into a plant is through openings in the leaves called stomata. The leaf stomata open or close as necessary to receive materials from the atmosphere for respiration and photosynthesis, or to prevent the entrance or exit of materials such as moisture. When the stomata are open, greater entry of materials from the atmosphere is possible. Thus, the action of stomata in the presence of SO_2 can have a direct effect on the SO_2 dose received by the plant.

s. Following uptake of SO_2 through the leaf stomata, contact of SO_2 within the leaf with wet cellular membranes, and subsequent liquid phase reactions result in the formation of sulfite (SO_3) and sulfate (SO_4) ions and/or compounds. Sulfite is an extremely toxic metabolic intermediate in the conversion of SO_2 to sulfate. Sulfate is incorporated by the plant into sulfur-containing amino acids and proteins. Plants thus have the ability to absorb, detoxify, and metabolically incorporate atmospheric sulfur.

t. While the capacity of a leaf to oxidize sulfite to sulfate will determine whether sulfite will reach toxic levels, as the level of sulfate increases over time beyond the ability of the leaf to metabolically incorporate it, toxic levels of sulfate can eventually be attained resulting in increased leaf senescence. Younger leaves have a generally higher photosynthetic rate and can more readily incorporate sulfate. The rate and stage of growth, as well as the concentration and duration of exposure, are, therefore, important factors in a plant's response to SO_2.

u. Such complex processes underlie the threshold level of adverse effect proposed by Blue Sky Advocates. Blue Sky asserts that the lowest concentration of SO_2 at which plants have been found to exhibit stomatal response is .01 ppm for one hour. (Unsworth, Exhibit 196, beans and maize, 1972) From this study is proposed the theory that stomatal response to SO_2, coming at the wrong time, could reduce yield. Plants open or close their stomata in response to a variety of environmental factors. Research has indicated that plants will open stomata in response to SO_2 at levels at least as low as .05 ppm and perhaps as low as .01 ppm. (Unsworth, Exhibit 196, p. 1; Biscoe, Exhibit 198) This effect of SO_2 is increased in plants which are water-stressed. (Exhibit 196, p. 2) Dr. Kohut has granted the potential exists for situations in which stomatal opening in response to SO_2 can increase evapotranspiration in a plant which is moisture-stressed. (TR Vol. 49, p. 7964, Kohut) However, Dr. Kohut asserts that such opening would not occur where the relative humidity is below 40%. (TR Vol. 50, p. 8014, Kohut) He does not believe that relative humidity will commonly exceed 40% in the Creston area. (TR Vol. 49, p. 7965, Kohut) Table 4.1-1 of Exhibit 179, based upon 22 years of Spokane data, shows that the only times relative humidity would be below 40% are the 4:00 p.m. readings for June, July, August and September and the 10:00 a.m. reading for July.

Bearing in mind that these figures are averages; that the highest SO_2 background levels of .008 ppm SO_2 approach the .01 ppm level of response; and that the accuracy of CRSTER modelling at these low levels is questionable, one cannot say with certainty that stomatal opening will not be caused by CGS SO_2 emissions. This is true even if the highest concentrations tend to occur in the summer months. (TR Vol. 49, p. 7941, Paulus) Stomatal response is subtle at best and its contribution to the ultimate injury or yield loss of a water-stressed plant would be, for all practical purposes, impossible to identify.

v. The additional information presented within the record is extensive and detailed on the subject of possible impacts of sulfur dioxide and acid rain on crop yields in Lincoln County. The Council has considered the additional information in respect to its Order No. 640 of May 24, 1982. Considering the preponderance of evidence in the record, the record shows that it is unlikely that crop yields in Lincoln County will be adversely affected by sulfur dioxide emissions from the Creston Generating Station within the limits established by this Order.

3. Acid Rain

a. General

1) Acid rain is a phenomenon which has received a great deal of attention recently. Acid rain refers to complex chemical reactions wherein atmospheric emissions of sulfur and nitrogen oxides are converted into acids and are deposited by rain or snow. Such materials can also be deposited in dry form and converted to acids by rain, fog, dew, or applied water. The acids most commonly involved are sulfuric acid (H_2SO_4) and nitric acid (HNO_3).

2) The acidity of a material is given a numerical value known as pH. The pH scale ranges from 0 to 14. pH 1 is

very acidic (battery acid), 7 is neutral and 13 is very alkaline (lye). pH is logarithmic in nature, so that pH 3 is 10 times as acidic as pH 4 and 100 times as acidic as pH 5.

3) Acid rain may be harmful in two main ways: by direct effect on plants, animals and structures; and by promoting the release of potentially harmful metals from soils and sediments (for example, aluminum).

4) Acid rain presents significant potential harm to the environment. Fish, for example, are known to be sensitive to acid accumulations. Lakes with pH values below 4.6 may become void of fish over time, due to the effects on reproduction. Lakes in the Adirondack Mountains of the United States are known to have become considerably more acidic since the 1930s. (App. Sect. 5.6-36) This acidity is attributed to depositions of sulfur and nitrogen oxides from industrial processes and other human activities.

5) Aquatic organisms other than fish may be injured by acid rain. Algae, plankton and other organisms are affected in extreme cases and changes in feeding patterns or relationships may occur.

6) Acidification may also have an adverse effect upon terrestrial plants. (App. Sect. 5.6-30) For example, long-term acidification may decrease the productivity of forest soils. (App. Sect. 5.6-30. DEIS Sect. 3-27) The magnitude of effects to the forest is largely unknown at this time. High levels of acidification are known to affect plant growth. (Ex. 45, Table 607-1) However, the long-term effects of lower concentrations are not as well understood. (DEIS, p. 3-29)

7) Acid rain was frequently mentioned at public hearings as a feared result of the operation of the CGS. This phenomenon is a particular and understandable concern of the farmers in the area whose livelihood is directly and inextricably connected to the fertility and characteristics of the soil. The optimum pH of soils for wheat growing is between 6.4 and 7.5 pH. (Creston hearing, Nov. 18, 1981, p. 35) Typical Creston area soils have a pH of 6.8. (Exhibit 179, p. 6.2-1) Any threat to the continued existence of these optimum conditions is naturally viewed with alarm.

b. Present and Predicted pH Levels

1) Normal rain in Lincoln County was measured in 1981 and the annual average pH was 5.18, with the pH of rainfall events extending from 4.35 to 6.36. (Exhibit 179)

2) The Applicant has modelled the predicted levels of both wet and dry acid deposition in Lincoln County. In its modelling, the Applicant assumed that NO_x and nitrates had a negligible effect on precipitation pH. Although Blue Sky Advocates would assign substantial significance to NO_x as a constituent of acid deposition, assignment of a zero or low value seems most appropriate, at least within the boundaries of Lincoln County. (Exhibit 179, pp. 3-17, 3-18)

3) The Applicant's modelling resulted in a predicted lowest event basis pH of 3.9. This event is predicted to occur within five kilometers of the CGS. Except for a narrow area north of the CGS, annual pH values, at a distance greater than 10 kilometers, are expected to be above 5.1. (Exhibit 179, p. 4-3) To the north, annual pH values could be reduced to approximately 5.0 within 5 kilometers and

to 5.1 at 25 kilometers. (Exhibit 179, p. 5-1) Most event basis pH values less than 4.3 are expected to occur within five kilometers of the CGS. None would occur beyond 20 kilometers. (Exhibit 179, p. 5-1)

c. Effects of Acid Deposition

1) A factor in measuring the effect of acid rain is the buffering capacity of the waters involved. It appears that the largest body of water in the area, FDR Lake, has a substantial buffering capacity which should not be significantly adversely affected by CGS operation. (App. Sect. 5.6-36)

2) The Council's analysis of this phenomenon is complicated by the fact that some of the nitrogen and sulfur compounds contained in acid rain have a beneficial nutrient effect on plants. In fact, sulfur and nitrogen in substantial quantities are added to cultivated soils through the application of fertilizers. (TR Vol. 46, pp. 7377-7381, Morrison) This makes indirect depositions of these compounds through acid rain that much more difficult to quantify.

3) The effects of increased acid in rainfall can also be substantially mitigated by the buffering capacity of the receiving soils. The soils in the region of the CGS in Lincoln County are known to have a high buffering capacity. All parties agree that detrimental acidification of soils in Lincoln County as a consequence of CGS emissions, will not occur. (TR Vol. 42, p. 6615, Wayne Williams; Exhibit 179, p. 6.5-1) Soils will be tested as provided in the Site Certification Agreement.

4) The question of pollutants accumulating in snowfall and then later being concentrated by snow melt was brought to the Council's attention by Donald George (TR Vol. 44, pp. 7055-7056, George). Mr. George later admitted that SO_2 would not be released by snow melt in that form. (TR Vol. 44, p. 7109, George) Mr. Paulus testified that any effect of snow melt on pH would be negligible. (TR Vol. 46, p. 7328, Paulus) Mr. Paulus also testified that snowfall accumulates very low levels of SO_2 and any decrease in melt water pH would be quite small. (TR Vol. 49, pp. 7910-7912, Paulus) SO_2 accumulation in snow would not result in a substantial decrease in snow melt pH.

5) The most controversial aspect of acid rain, on the record before the Council, is the predicted effect on plants caused by rainfall with a lowered pH actually striking the plants. It appears that plants close to emission sources may accumulate acid-producing materials on leaf surfaces which may lower the pH values (make more acidic) of rainfall passing through the leaf canopy. (Exhibit 179, p. C-14) Plant leaves further removed from emission sources seem to have the ability to buffer rainfall. (Exhibit 179, p. C-14) In laboratory conditions, plants have sustained injury from exposure to acidic solutions. (Exhibits 179, pp. C-17, C-18) Acid rain may play a part in host-parasite interactions. (Exhibit 179, p. C-19) Yet, the witness most critical of acid rain, Dr. Wayne Williams, stopped short of predicting actual yield loss from rainfall with a pH of 3.9. (TR Vol. 42, pp. 6614-6615, Wayne Williams)

6) Based on the record, the Council finds that acid rain at the pH levels predicted should have no effect on wheat,

barley or alfalfa production. (Exhibit 179, pp. 7.1-9; 7.2-3; and 7.3-8) The effects of acid rain on the forest species occurring in Lincoln County have not been researched. Extrapolation from studies of other species indicates that no effects should be anticipated. (Exhibit 179, p. 9.3-3) There has been no study on the effects of acid rain on rangeland vegetation. Research on crop plants suggests that range grasses may be resistant to acid deposition. However, this assumption cannot be confirmed without further research. (Exhibit 179, p. 8.2-1) Drs. Kohut and Lefohn testified that no study had documented adverse effects of acid rain on terrestrial vegetation.

7) The findings and conclusions of the Council regarding the pH of precipitation, are not based, in any way, upon any of the prepared testimony which was submitted on behalf of Dr. Larson and later withdrawn. The findings and conclusions of the Council are strictly based upon the testimony presented by the Applicant and Blue Sky Advocates through their witnesses and evidence in the contested case record.

8) The effects of acid rain on crops are not completely understood. Based upon what is now known, the Council would not expect CGS operation, as controlled by provisions which should be included in the Site Certification Agreement, to have significant adverse effects. Monitoring to confirm predicted pH levels and to study possible effects is appropriate.

9) The Council can say with assurance that the effects of any acidification of precipitation which may occur as a consequence of CGS operation, will be nowhere near the magnitude of the effects in areas (such as the Ohio

Valley) where there are many coal-fired plants, burning high sulfur coal, located close to one another, utilizing minimal SO_2 controls. (TR Vol. 14, p. 2255, Paulus)

C. Control Technology

1. Sulfur Dioxide (SO_2)

a. There are presently 16 flue gas desulfurization (FGD) systems (at eight coal-fired plants) with greater than 90 percent sulfur removal efficiencies operational in the United States. (TR Vol.28, p. 4397, Paulus) For 13 of these systems, the total emissions exceed those which would occur if the CGS were to operate at 86.5 percent efficiency with coal D because higher sulfur coal is being burned in the other plants.

b. Greater removal efficiencies remove more materials which results in more solid waste disposal. On the whole, this is an environmental benefit. As discussed elsewhere in these Findings, the Council is confident that solid waste disposal conducted as required will not have a significant adverse environmental impact. It is preferable to have these materials deposited in one discrete location where both potential adverse impacts and controls are well understood than to have them released into the atmosphere and deposited by the winds and rain in ways and with effects predicted by computer models and published scientific research.

c. The Prevention of Significant Deterioration (PSD) increment for the Creston area serves as a limitation of future industrial expansion. With four units operating at maximum guaranteed rating, the models used predict substantial use of the PSD increment at one location on Johnny George Mountain. Although the record does not reveal any planned activity in the area which would be threatened by using all but 0.1 ug/m^3 (micrograms per cubic meter) of the available 24-hour incre-

ment in the area (VALLEY model) or 32.4 ug/m^3 of the available increment (COMPLEX 1 model), the PSD limitation creates an exhaustible and perhaps irretrievable resource. Allowing emissions beyond those necessary to provide a commensurate benefit to the state in project development and energy production may place an unnecessary limit on future development in the area; however, the Council finds the risk of limiting future progress to be small.

d. In its PSD application, Water Power initially proposed the installation of an SO_2 control system capable of removing 86.5% of the SO_2 from stack gases without regard to coal ultimately selected. After CRSTER and the ensuing air quality analysis supported the assertion that that there would be no demonstrable adverse affects on vegetation at an emission rate of 4,560 pounds per hour, the Applicant modified its proposal. Water Power now proposes to purchase and install SO_2 control equipment capable of scrubbing at an efficiency level which will introduce no more SO_2 into the atmosphere than 4,560 pounds per hour on a 24 hour rolling average.

e. If coal D is selected as fuel, the consequent percent control would be 86.5%, under the Applicant's proposal. If, however, some other coal is selected, the maximum percent efficiencies required to emit no more than 4,560 pounds per hour on a 24 hour rolling average would be: coal A, 73%; coal B, 77%; coal C, 79%; and coal E, 83%. In this setting, the selection of coal A or B, for instance, may allow the Applicant to purchase an FGD System with a capacity of 75-80% control. Further, the equipment may be operated most of the time at 70% control, as a consequence of shutdowns or reduced loads.

f. The Applicant has committed to purchase and operate a control system capable of 86.5% control of coal D. However, it would

cost less to scrub a lower sulfur coal to an 86.5% removal efficiency than it would cost for the same efficiency with coal D. In this fashion, the dynamics of coal selection may lead to a reduction in scrubbing costs below those figures submitted to the Council. Savings would result as a consequence of reduced capital expenses for sizing of the FGD system and reduced operating costs for operation at lower scrubbing efficiencies. The Applicant requests cost savings and variable operating rate flexibility based upon the proposition that there would be no demonstrated effect to crops from emissions at 4,560 pounds per hour, the conclusion of its air quality analysis. Why, inquires the Applicant, should it be required to release less SO_2 to the environment than 4,560 pounds per hour when there will be no demonstrated benefit?

g. Best Available Control Technology (BACT) is determined on a case-by-case basis taking into account energy, environmental and economic impacts and other costs, (WAC 463-39-030). A scrubbing efficiency of 90% is achievable for any of the coals proposed as potential fuels for the plant. A BACT determination has been requested for all four units of the CGS, though the final unit will not be producing energy until 1995 by the present schedule. Sulfur control technology is developing, particularly toward reducing costs of scrubbing at high levels of percentage removal.

h. This time setting is the principal reason for the proposal of WDOE that the BACT determination for units 3 and 4 be reserved to a future time when more is known about plant responses to SO_2, potential for crop losses from SO_2, and advances in SO_2 control technology. Presumably the procedure for such a review might involve an entirely new air quality application for units 3 and 4. The consequent delays and uncertainties could significantly complicate planning and engineering design for those units.

i. The record establishes that any adverse effect on crop yields from CGS emissions would be practically impossible to demonstrate in the field setting of climatological stress, plant disease and infestation. As a consequence, there is no scenario for mitigation of crop losses other than one peopled by lawyers and experts arguing contradictory theories about a matter which cannot be resolved to a known. No meaningful mitigation can be expected where crop losses cannot be proved, if they, in fact, occur.

j. The Applicant wishes the most predictable regulation of all four units at the lowest cost within the BACT formula. Blue Sky Advocates opposes the project, but if the CGS is certified, advocates high levels of sulfur control designed to eliminate any possibility of crop loss or damage.

k. The Applicant's assertion of no demonstrable adverse effect at 4,560 pounds per hour SO_2 emission is persuasive. However, the analysis supporting the assertion relies on assumptions and techniques which are uncertain. Though one cannot equate Water Power's analysis to a flashlight shone in a darkened room, neither is the room so well lighted that all its corners, cracks and contours can be readily seen. Future circumstances may cause economic loss to farmers, which cannot be readily mitigated.

l. In determining the appropriate method to control SO_2 emissions, the Applicant and the Council have considered various technologies. These technologies included pre-combustion fuel desulfurization, wet and dry limestone flue gas desulfurization (FGD), lime FGD, alkaline fly ash FGD, wet soda FGD, and magnesium oxide FGD. Based upon the record, the wet limestone flue gas desulfurization method:

1) has been proven in large-scale applications;
2) is capable of efficiencies greater than 90%;
3) could use locally available limestone; and
4) is, compared to other reasonable technologies, the least expensive. (TR Vol. 13, p. 2061, Paulus)

At the present time, wet limestone flue gas desulfurization is the preferred technology for CGS SO_2 control. However, the Applicant should be allowed the latitude to select a different technology in the future, if such technology offers equivalent or better SO_2 removal.

m. BACT for all four units cannot be established at the limits proposed by the Applicant. If all four units are to be permitted by the Air Quality Permit, higher controls must be required. BACT for all four units is the following:

1) Flue gas desulfurization technology capable of removing 86.5% SO_2 for coal D for units 1 and 2 and 90% SO_2 for coal D for units 3 and 4.

2) SO_2 emissions limits for units 1 and 2 would be:
   a) 0.22 lb/mmbtu on a 30-day rolling average;
   b) 1,250 pounds per hour per unit on a 24-hour rolling average;[1]
   c) 2,500 pounds per hour per unit; maximum one hour emission not to be exceeded more than once in thirty days.[1]

[1]Emissions limits are based upon maximum unit operation of valves wide open 5% over-pressure capacity and SO_2 control equivalent to 86.5% sulfur scrubbing of coal D.

3) SO_2 emissions limits for units 3 and 4 would be:

a) 0.16 lb/mmbtu on a 30-day rolling average;

b) 925 pounds per hour per unit on a 24-hour rolling average;[2]

c) 1,850 pounds per hour per unit; maximum one hour emission not to be exceeded more than once in thirty days.[2]

4) The SO_2 emissions limit for plant-wide operation would be 4,000 pounds per hour for all four units on a 24-hour rolling average basis, not to be exceeded more than once in 30 days.[3]

n. Emissions controlled within these limits will reduce total SO_2 emissions to the atmosphere by as much as one-third over the Applicant's proposal, in a given year. Fluctuating operating rates of sulfur removal equipment within the limits will provide needed operational flexibility. Economic burdens on the Applicant are reasonable, considering the plant construction schedule and the setting of the plant in a prime agricultural area. The Applicant will be assured of certain SO_2 control constraints for all four units which will assist in engineering design and management of costs.

[2]Emissions limits are based upon maximum unit operation of valves wide open 5% over-pressure capacity and SO_2 control equivalent to 90% sulfur scrubbing of coal D.

[3]The plant-wide emissions limit is based upon four units operating at guaranteed nameplate rating.

o. Within the present state of scientific understanding of SO_2 effects on crops, emissions limited by these controls will eliminate any realistic possibility of adverse effects to crops in Lincoln County as a consequence of emissions from the CGS.

p. These limitations were established with the expectation that Water Power will, prior to construction, submit to the Council for approval, detailed design information identifying the specific control equipment to be used and the guarantees and warranties which will be required from manufacturers. (TR Vol. 28, pp. 4443, 4444, Henriques)

2. Nitrogen Oxides (NO_X)

NO_X emissions are controlled by boiler design and operational characteristics. NO_X emissions can easily be limited to less than 0.5 lb/mmbtu for subbituminous coals and 0.6 lb/mmbtu for bituminous coals by the use of the boiler design proposed and proper operational controls. The conceptual boiler design proposed by the Applicant constitutes "best available control technology" (BACT) if operated properly. The Applicant will be required to submit for approval, all operational criteria prior to commencing operation. The Council should specify operational criteria in the Site Certification Agreement. Design specifications and guarantee requirements will be subject to Council approval as provided in the Agreement.

3. Cooling Tower Impacts

The four proposed, 12-cell circular mechanical draft cooling towers are reasonable and appropriate to mitigate the occurrence of visible plumes. The towers will also reduce off-site salt deposition levels to less than 2000 kilograms per square kilometer/month, as provided by the Site Certification Agreement.

4. Particulate Emissions

a. In Table 4.2 of the supplemental BACT submittal to EPA, the Applicant's Prevention of Significant Deterioration document, Water Power lists various sources of fugitive particulate emissions and proposed types and levels of controls. These controls are generally reasonable and appropriate with the exception of certain sources and controls which should be treated in the Site Certification Agreement.

b. Stack particulate emissions can be limited to the New Source Performance Standard (NSPS) of less than 0.03 lb/mmbtu, per unit, by the use of a baghouse, containing fabric filters. This constitutes best available control technology. The Council further finds that similar results could be expected from the use of electrostatic precipitators and would consider approval of such devices if detailed designs were first submitted to the Council. Approval of design specifications and guarantee requirements will be required before control facility construction and operation may commence. The particulate matter emission removal efficiency will be at least 99% for each unit, as established by performance tests.

5. Stack Height

The emissions stacks themselves are a method of mitigation. The design and height of the stacks encourage mixing and dispersion of emissions and minimize the possibility of icing or fogging. The proposed 555-foot stack height is consistent with good engineering practice.

6. Opacity

Particulate matter opacity levels will not exceed state or federal standards. Specific limitations should be established in the Site Certification Agreement.

7. Carbon Monoxide and Volatile Organic Compounds

Optimum combustion efficiency minimizes the production of carbon monoxide and volatile organic compounds. Boiler design and operation are the controlling factors. Optimizing combustion constitutes best available control technology for these emissions. Design specifications and guarantee requirements should be reviewed by the Council prior to construction to ensure these emissions are minimized, in accordance with the Site Certification Agreement.

8. Monitoring

The record establishes that if CGS emissions adversely affected crop yields by as much as five percent, that effect would be very difficult, if not impossible, to isolate in view of the many other variables that can affect crop yield. (TR Vol. 47, p. 7506, Morrison; TR Vol. 45, p. 7204, George). If pollutant damage did occur, it might very well escape attention. The Council must therefore place its primary reliance upon appropriate controls to avoid the possibility of such damage in the first instance. Still, an appropriate monitoring program has a place and a value to test predictions upon which emission control requirements have been based, measure concentrations and identify, to the extent possible, effects. Air and vegetation monitoring should be required by the Site Certification Agreement and developed prior to the operation of the first CGS unit.

3. If constructed, this line will have sufficient capacity to carry the entire production from four units of generation, 2032 MW. Connection with the upgraded line would physically connect the entire output of the CGS with the Northwest Power Grid. Though the 500 kV upgrade is planned whether any units of CGS are built or not, much of the ultimate load on the line is eventually seen to originate at the CGS. The Council cannot order BPA, an agency not a party to this proceeding, to build the line. At this point, 500 kV upgrade is an expectancy backed by qualified assurances of BPA executives.

4. The capacity from the double circuit 500 kV line is relied upon by Water Power for transmission of the balance of participants' shares of CGS generation, ultimately 75 percent of 2,032 MW. Two of Water Power's transmission proposals rely upon 500 kV construction being completed by BPA. The remaining proposal, the southern 500 kV, is presented as an alternative in the event BPA does not upgrade to 500 kV service on its northern corridor. These Findings assume the necessary upgrade will occur. If this assumption is proved by subsequent events to be in error, use of an identified alternative transmission route must be approved.

5. At the present time, there is no 500 kV service on the BPA corridor or in the Spokane vicinity. The first will approach Spokane in approximately 1984 when a line of this size is connected to the Bell Substation from the east, carrying power from the Colstrip stations in Montana. The introduction of this service will accommodate, if not require, adjustments and upgrades to the transmission network in the Spokane area and along the northern corridor. This requirement, or opportunity, to upgrade 500 kV service is a matter which is incidental, if not independent and collateral, to the requirement to integrate CGS generation to the existing transmission system. This improvement is similar, in terms of its impact on this proceeding, to the Applicant's evidence regarding support to the Lind-Harrington

area and various 1990 reliability requirements for general transmission systems in Eastern Washington and Greater Spokane. This licensing proceeding, though providing an occasion for considering contingent and planned aspects of the total transmission setting, is principally concerned with simple connection with the existing energy distribution network. Stated another way, system engineering requirements of a wide region into the distant future become a remote concern once output from the plant is physically connected to existing transmission networks. See RCW 80.50.020(6)

6. The presence of transmission facilities within five miles of the plant is a compelling reality, a reality no doubt perceived and relied upon by the Applicant in siting the plant. The fact that this corridor is owned and operated by an agency of the federal government charged with managing a major portion of the Northwest Power Grid - the "one utility" concept - adds further weight to this circumstance. Without regard to issues of cost and reliability, physical connection with BPA's proposed 500 kV system in the northern corridor will integrate CGS output into the Northwest Power Grid and allow transmission of energy to all plant subscribers.

7. BPA is an agency of the federal government, organized pursuant to federal law. It is required to accept and transmit energy provided to it, where capacity exists, on a nondiscriminatory basis according to published rate schedules. As a government agency, BPA does not seek profit nor is it allowed to acquire and accumulate profit. The rates charged by it for transmitting energy (wheeling) are, by design, directly caused, related to, and determined by the costs and expenses incurred by BPA in providing transmission service. (TR Vol. 37, pp. 5493-5506)

C. Proposed Facilities

1. Well field

The well field near FDR Lake will require electric energy. Providing this energy will require the construction of 12 miles of 115 kV transmission line and a distribution substation at the well field. The energy will be supplied by the Lincoln Electric Cooperative.

2. Water Power has proposed three alternative transmission systems to integrate CGS output into the existing transmission network. Various proposals have some elements in common. BPA has described an alternative to one of the proposals. The three alternatives proposed by the Applicant are referred to as the Northern Double Circuit 500 kV Alternative (Northern Alternative); the Southern Single Circuit 500 kV Alternative (Southern Alternative); and the Southern Double Circuit 230 kV Alternative, preferred by Water Power (Preferred Alternative).

a. Northern 500 kV

The Northern Alternative includes a double circuit 500 kV line running from the CGS to the Douglas Switchyard, near Grand Coulee; and a double circuit 500 kV line running from the CGS to the Bell Substation with one of the 500 kV circuits looped into and out of the future Marshall Substation. One 230 kV line would be looped into the CGS for station service. 500/230 kV transformers would be located at the Bell Substation and Marshall. Two of the 230 kV transmission lines on the existing BPA right-of-way would remain connected to the Bell Substation with one of the 230 kV circuits being connected to the Marshall Substation, by interconnection at the existing substation at Westside.

b. Southern 500 kV

The Southern Alternative includes a single circuit 500 kV line from the CGS to the Douglas Switchyard utilizing a route which lies generally southerly of the existing BPA right-of-way.

Three of the 230 kV lines on the existing BPA right-of-way would be connected to the transformer at Douglas. A 500 kV transmission line would connect the CGS to the future Marshall Substation. A 500 kV line would run from Marshall to the BPA right-of-way on the North-South connector. A 500/230 kV transformer at Marshall is proposed by this alternative. Marshall would also be connected by 230 kV line to the westside substation which would, in turn, be connected to existing 230 kV lines on the BPA right-of-way. Three 230 kV circuits on the BPA corridor would be connected with the proposed CGS.

c. Southern Preferred 230 kV

The Preferred Alternative provides for construction of double 500 kV circuits utilizing the existing Bonneville Power Administration's right-of-way in Lincoln County from the Creston Generating Station west to the Douglas Switchyard. Double 500 kV circuits would also extend eastward from the CGS to the BPA Bell Substation north of Spokane utilizing the existing BPA right-of-way. A unique feature of this plan is a double circuit 230 kV transmission line from the CGS to the future Marshall Substation south of Spokane. The line would be constructed, owned and operated by the Applicant. 500/230 transformation facilities would be constructed at CGS, in this proposal. No new construction would occur in the sensitive north-south corridor between Marshall and the BPA right-of-way. Also, no looping of one of BPA's 230 kV lines into the CGS to provide station service would be required.

d. Comparison of Routing

The common routing features of the various alternatives can be described as follows:

1) Both the Northern and Southern 500 kV Alternatives involve the construction of transmission facilities between the BPA right-of-way (ROW) and the Marshall Sub-

station for a distance of approximately 16 miles. This is the North-South Connector.

2) Both the Southern 500 kV and Preferred Alternative involve construction along new ROW to be owned by the Applicant south of the CGS connecting CGS with the Marshall Substation, a distance of approximately 60 miles.

3) Both the Northern and Preferred Alternatives involve construction of double circuit 500 kV lines on the existing BPA ROW from the Douglas Switchyard to CGS and from CGS to the Bell Substation for a distance of approximately 83 miles.

4) All of the alternatives contemplate a connection between the CGS and the BPA ROW near the plant for a distance of approximately five miles.

5) The Southern 500 kV alternative has one routing feature which it does not share with any of the other alternatives. In this plan, a route runs from CGS west to the Douglas Switchyard on a line south of the BPA ROW for a distance of approximately 36 miles, with another six miles along the BPA ROW to Douglas.

3. North-South Connector

The North-South Connector, a route of approximately 16 miles, is complicated by the relatively intense development of land uses along it, when compared to uses in the northern and southern corridors. The Spokane International Airport is in close proximity to the right-of-way as is Riverside State Park. There is more intensive residential development, a highway crossing and view impacts to the Indian Canyon Park Area. Fairchild Air Force Base is in the same general vicinity. Although construction of transmission facilities in this area