and (5) the fact that the net environmental benefit to be obtained from capture is not commensurate with (1)-4.

PLS strongly believes that any attempt to capture the leading edge of the plume would be fruitless and potentially catastrophically expensive and litigious. PLS would have to assume an unacceptable risk that even after the expenditure of tens of millions of dollars without achieving a commensurate environmental benefit, some portion of the plume may still escape, leaving PLS in the same legal jeopardy that it now faces.

(a) The remedial action selected or approved will, within a reasonable period of time, attain a standard of performance that is equivalent to that required under R 299.5705(5) or R 299.5705(6) of the Michigan administrative code.

Based on its understanding of the MDEQ's interpretation of this provision, PLS is not seeking a waiver under this subsection.

(b) The adverse environmental impact of implementing a remedial action to satisfy R 299.5705(5) or R 299.5705(6), or both, of the Michigan administrative code would exceed the environmental benefit of the remedial action.

<u>Benefits</u>

The potential benefits to be gained by a containment remedy that would comply with R 299.5705(5) are limited. All seven of the surviving alternatives, including Alternatives 2 and 6, which would not contain the plume, are equally protective of the public health and the environment. All assure that receptors are not exposed to 1,4-dioxane levels in excess of allowable criteria. The only differences between alternatives from this standpoint do not appear to be material. The five "leading edge" alternatives (all but 2 and 6) would by design prevent expansion of areas of contamination above drinking water criterion. Alternative 2 would not, by design, contain the plume at all, while Alternative 6 would contain the plume as necessary prior to any potential impact on downgradient receptors. These distinctions make little or no practical difference in terms of protecting the public health and the environment. Under any alternative, no one would actually be consuming groundwater contaminated with 1,4-dioxane above acceptable criteria. And over time, roughly the same area of the Unit E would contain detectable levels of 1,4-dioxane (no matter which alternative is selected) because, by design, even the "leading edge" alternatives would allow concentrations of 1,4-dioxane below 85 ppb to continue to migrate. For this reason, as long as no one will be drinking the water, the "benefit" of protecting a portion of the plume from concentrations over the drinking water cleanup criterion is negligible if not completely absent. Finally, it is not possible to quantify the difference in area inside a "leading edge" containment alternative versus alternatives 2 and 6. This is because all of the leading edge alternatives are subject to significant uncertainty (in timeliness) because of access and other practical implementation issues. As discussed above, it is not necessary to undertake mass removal, let alone containment, in order to obtain the "benefit" of protecting downgradient receptors.

Even if the Ridgmor wells are ultimately affected (and it doesn't appear that they will be), they are already scheduled to be taken out of service. The Montgomery Well was removed from service because 1,4-dioxane was detected at 2 ppb. As alleged in the City's lawsuit, the City of Ann Arbor has no intention of restarting this well, even if the legally enforceable "leading edge" is captured since detectable levels of 1,4-dioxane may still reach the well. Groundwater modeling demonstrates that the proposed interim response can attain all of the other objectives satisfactorily.

Detriments to the Environment

The pumping and treatment of 1,4-dioxane contaminated groundwater is not an environmentally benign process. The intrusive measures involved in the purging and treatment of groundwater in order to achieve partial restoration of the aquifer results in more environmental harm that is gained. The following examines the negative environmental impacts that would be expected if groundwater is extracted at a rate of 500 gpm (well below the 570 to 650 gpm that would be needed to capture the leading edge), transferred to the PLS for treatment, and discharged into the Honey Creek Tributary. This is not an exhaustive list.

Groundwater Water Level Decline

If PLS is required to pump 500+ gpm from the Unit E aquifer, the combined groundwater remediation at the PLS site would involve the extraction of over 1,800 gpm of groundwater on a continuous basis. Water level decline is a natural response to pumping from an aquifer. Water level declines of approximately 12 feet have been observed in the Pall site area as a result of the aggressive pumping underway in the Unit C3 and D2 Aquifers. This decline would increase if groundwater were to be extracted from Unit E. Water level decline from pumping Unit E would eventually manifest itself in all overlying aquifer or water bearing deposits. Water level declines ultimately result in a reduction of discharge to surface waters, lowering of surface water levels, and a reduction in the capacity of an aquifer to support other uses.

To put the magnitude of the proposed purging in context, the recent well-known *Nestle* groundwater removal litigation is a good example. In that case, a lawsuit was commenced over the proposed withdrawal of 300 to 400 gpm, with no demonstrated reduction in water table levels. As mentioned earlier, adding 500+ gpm for the Unit E would make the volume of PLS's purge program three times larger than that in *Nestle.*

Surface Water Level Decline

The importance of considering ground water and surface water as a single resource has become increasingly evident in recent years(Winter, et al). Excessive groundwater extraction can result in groundwater level declines that eventually result in surface water level declines. The aggressive groundwater pumping associated with the Unit C2 and D2 aquifers has already lowered groundwater in some locations by approximately 12 feet. Continued pumping at PLS plus additional purge operations to contain the E plume at Maple Village would lower the groundwater, and the surface water bodies even more. The time lapse between the pumping of groundwater in an area and the noticeable reduction of surface flow further complicates the situation as the time lag may be as brief as a single growing season or as long as 30 or 40 years. Because of this time factor, a cause-and-effect relationship between pumping and reduced stream flow may not be readily apparent.

Surface water bodies in the area of the Pall site include the Honey Creek Tributary, First, Second and Third Sister Lakes. It is likely that the surface water levels in these water bodies will be lowered as a result of aggressive pumping

Pumping and Transmitting Water

Electrical energy is consumed during the pumping and transmission of groundwater. Groundwater weighs approximately 8 pounds per gallon. Lifting and transporting this relatively heavy fluid requires a significant amount of energy. Pumps for water lifting and transmission are generally powered by electricity. Energy consumption for the movement of 500 gpm of water has been calculated as part of this Feasibility Study (Appendix E).

The approximate depth to groundwater (i.e. an approximate pumping level) in the Unit E is 50 feet. Lifting water that height from four wells and transmitting it to a treatment center at Pall and then discharging it to the Honey Creek Tributary is estimated to consume approximately 1235 kWh/day. This equates to approximately 450,775 kWh of annual energy consumption. Over the course of the cleanup, it is estimated that over 9,000,000 kWh of energy would be consumed. For comparison, the average household consumes approximately 25 Kwh/day, thus the energy devoted to pumping would supply the needs of approximately 50 households per day.

Treatment of Water

Pall currently uses Ultraviolet light and hydrogen peroxide for the ex-situ treatment of 1,4-dioxane. This is a very energy intensive process. The approximate electrical usage for UV/H202 treatment at a 500 gpm treatment rate is 9840 kWh/day (approximately 400 households). If treatment were to be by ozone/H202, the approximate energy cost for a 500 gpm rate would reduce to approximately 3600 kWh/day (approximately 144 households).

The production of electricity creates air emissions. The USEPA air emission factors for electric generating plants are indicated in the tables below. By calculating the potential or estimated coal and gas usage resulting from the pumping at Pall, the estimated emissions from electric power generation using coal can be calculated. From these estimates the potential emissions form energy consumption can be calculated.

Estimated Emissions from Electric Power Generation (Coal)

Energy Use (kWh/day)	Btu/day	Btu Value of Coal (Btu/lb)	Coal Usage (lb/day)	Coal Usage (ton/year)
Pumping/Transfering Water - 1,235	4,215,055	13,000	324	59
Treating water with UV/H202 - 9,840	33,583,920	13,000	2,583	471
Treating water with Ozone/H202 - 3,600	12,286,800	13,000	945	172

Pollutant	Emission Factor (lb/ton Coal)[1]	Coal Usage (tons)	Emissions (tons/Year)
CO	0.5	59	0.01
Lead	0.00042	59	0.00001
Nox	11	59	0.33
SO2	32.8	59	0.97
PM2.5	0.025	59	0.001
PM10	0.054	59	0.002
PM Total	0.012	59	0.0004

Pollutant	Emission Factor (lb/ton Coal)[1]	Coal Usage (tons)	Emissions (tons/Year)
CO	0.5	471	0.12
Lead	0.00042	471	0.0001
Nox	11	471	2.59
SO2	32.8	471	7.73
PM2.5	0.025	471	0.01
PM10	0.054	471	0.01
PM Total	0.012	471	0.003

Pollutant	Emission Factor (lb/ton Coal)[1]	Coal Usage (tons)	Emissions (tons/Year)
CO	0.5	172	0.04
Lead	0.00042	172	0.00004
Nox	11	172	0.95
SO2	32.8	172	2.83
PM2.5	0.025	172	0.002
PM10	0.054	172	0.005
PM Total	0.012	172	0.001

USEPA, 1998 - SCC: 1-01-002-02, External Combustion Boilers, Electric

Power Generation, Coal

Estimated Emissions from Electric Power Generation (Natural Gas)

Energy Use (kWh/day)	Btu/day	Btu Value of Natural Gas (Btu/CF)	Natural Gas Usage (CF/day)	Natural Gas Usage (MMCF/year)
1,235	4,215,055	1,020	4,132	2
9,840	33,583,920	1,020	32,925	12
3,600	12,286,800	1,020	12,046	4

Pollutant	Emission Factor (lb/MMCF)[1]	Natural Gas Usage (MMCF)	Emissions (tons/year)
CO	84	2	0.084
Lead	0.0005	2	0.0000005
NOx	100	2	0.10
SO2	0.6	2	0.001
PM Total	7.6	2	0.00760
VOC	5.5	2	0.0055

Pollutant	Emission Factor (lb/MMCF)[1]	Natural Gas Usage (MMCF)	Emissions (tons/year)
CO	84	12	0.50
Lead	0.0005	12	0.000003
NOx	100	12	0.60
SO2	0.6	12	0.00
PM Total	7.6	12	0.05
VOC	5.5	12	0.03

Pollutant	Emission Factor (lb/MMCF)[1]	Natural Gas Usage (MMCF)	Emissions (tons/year)
CO	84	4	0.17
Lead	0.0005	4	0.000001
NOx	100	4	0.20
SO2	0.6	4	0.001
PM Total	7.6	4	0.015
VOC	5.5	4	0.011

USEPA 1998- SCC: 1-01-006-02, External Combustion Boilers, Electric Power Generation, Natural Gas

Chemical Usage During Treatment

A significant amount of chemicals are required for the treatment of 1,4-dioxane. If 500 gpm of water were to be treated using UV/H202, the following mass of chemicals would be consumed per day:

Chemical	Mass (pounds/day)	Mass (pounds/year)	Mass (pounds/20 year)
Acid	2,556	932,940	18,658,880
Peroxide	1076	392,740	7,854,800
Caustic	4,529	1,652,720	33,054,400

If 500 gpm is treated by peroxide/ozone, the chemical mass/volume is reduced to:

Chemical	Mass (pounds/day)	Mass (pounds/year)	Mass (pounds/20 years)
Peroxide	648	236,520	4,730,400
	Volume (cubic feet)	Volume (cf)	Volume (cf)
Liquid Oxygen	21,600	7,884,000	157,680,000

Chemical Discharge to Surface or Groundwater

The discharge of treated groundwater necessarily results in alteration of the natural water chemistry, whether it is discharged to surface water or reinjected into the aquifer. PLS has already had one failure of its chronic toxicity criteria in connection with its surface water discharge. PLS has altered its treatment process and developed its ozone treatment technology to address this concern, but when compared to the nonexistent environmental benefit of treating the additional Unit E water, it is not clear that even the minimal risks associated with the discharge of treated groundwater are worth it.

Other Environmental Concerns

Mixing of water from different aquifers or water bearing zones.
Damage to trees during infrastructure installation
Increased truck traffic and related energy usage and air emissions – Necessary to deliver chemicals
Increased potential for spills during transportation of treatment chemicals.

(c) The remedial action provides for the reduction of hazardous substance concentrations in the aquifer through a naturally occurring process that is documented to occur at the facility and both of the following conditions are met:

The Unit E plume is subject to natural processes (physical, chemical, or biological) that act to reduce the mass, toxicity, volume and concentrations of 1,4-dioxane. At a minimum, these in-situ processes include dispersion, dilution and sorption and biodegradation.

The physical processes of dispersion and dilution have been documented to occur at the PLS site and are working to reduce 1,4-dioxane concentrations anywhere plumes have migrated, including the Unit E plume. For example, these processes have played an important role in reducing 1,4-dioxane