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| **Pollution And Pollutants*****1. Introduction*** *1.1 Defining Pollution*Most people are now "environmentally aware" and understand the term pollution. One definition may be: the introduction into the environment (air, water or land) of contaminants, the quantities, characteristics, and duration of which are likely to be injurious to human, animal, or plant life.This is reasonably comprehensive. However, many variations exist. Within the UK Environmental Protection Act 1990 (EPA) itself there are slight differences in different sections. In Section 29 Part II, which deals with wastes on land, pollution is:"*the escape of any substance capable of causing harm to man or any other living organisms supported by the environment*."While at the beginning the Act states:"*Pollution of the environment means pollution of the environment due to the release (into any environmental medium) from any process of substances which are capable of causing harm to man or any other living organisms supported by the environment*."The use of the word "release" implies a more wilful act than escape. The same section proceeds to define "release":"release" includes:a) in relation to air, any emission of the substance into the air;b) in relation to water, any entry (including any discharge) of the substance into water;c) in relation to land, any deposit, keeping or disposal of the substance in or on land.In this definition alone are introduced other words synonymous with "release" such as emission, entry, discharge, deposit, disposal. As far as we are concerned we can be a little more precise and say that:*Pollution may be caused by any substance whether natural or industrially produced, or by waste energy*.Energy, which includes noise and waste heat, has not been designated as a pollutant in other definitions. If we are to link resource conservation with the problems of pollution and its control we must be aware of waste heat and other forms of energy "lost" in day-today activities, both domestic and industrial.We must also say that:*Humans are responsible, not only for creating new alien or toxic substances which have no natural place in the environment, but by adding to natural substances (making too much or too many) which can be just as damaging, and by wasting resources*.Also, once pollution has occurred:*The significance of the polluting effect is related to the range of targets (for example, human health, ecological systems, buildings or amenity) and to their susceptibility*.*1.2 The Biosphere*All life exists in that part of the earth and atmosphere which is called the biosphere and it is into this environment that all pollutants are discharged. The biosphere includes land and soil, the atmosphere, rivers, lakes and deep ocean beds and sediments. All organisms, plant and animal, live in a variety of physical environments within the biosphere. The organisms (biota) together with their particular physical environment (habitats), form an ecosystem in which complex interactions take place.All forms of life on earth need:* 1. A usable energy supply
	2. Water
	3. Nutrients, which are certain chemical substances (including air/oxygen) essential for life processes of plants and animals.
	4. A suitable temperature and other physical conditions.

It is the provision or existence of these conditions which may be at risk when pollution occurs.*1.3 Plant & Animal Nutrients*Table 1 shows two lists of chemical essential for the growth and development of plant and animals. There are major and minor biological essentials, the distinction depending upon the quantity required by the plant or animal during growth and reproduction. The minor elements are often called trace elements in human nutrition.

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| **Table 1**: Biological essential elements |

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| **Major Elements**  | **Minor Elements** |
| CarbonHydrogenOxygenNitrogenPhosphorusPotassiumSulphurCalciumMagnesium  | IronCopperZincManganeseMolybdenumBoronCobaltSiliconIodineSodiumChlorineVanadium |

These are all examples of chemicals that are biologically necessary. The first three major elements are obtained from the atmosphere. So too, to a lesser extent is nitrogen. But the majority of the elements are taken by the plants from soil and water. The major elements have a wide range of functions: for instance, nitrogen is a component part of all proteins and carbohydrates are compounds formed from carbon, oxygen and hydrogen.*1.4 Natural & Industrially Produced Pollutants*So far we have discussed elements and their compounds which are necessary for life and are produced naturally. Some of these elements or their compounds are also produced by human activities. For example, when fossil fuels such as coal and oil are burnt, carbon dioxide is produced (from carbon and oxygen); this adds to any carbon dioxide which is naturally in the atmosphere.Another aspect of human interference in the environment is that even though some elements and their compounds at certain concentrations are essential for life, they may be injurious or even toxic at higher concentrations (for example, oxygen and nitrogen oxides). Non-essential elements such as mercury, lead and cadmium may also be increased and totally new substances which are not known in nature may be produced (organochlorines, for example) and then be physically distributed by various means within the environment.Mercury, lead and cadmium are normally called heavy metals. The elements themselves and their salts are physiologically toxic. Heavy metals are widespread in natural waters, soil and rocks but occur at very low concentrations. As well as being toxic, they have no known biological function, but when they are released into the environment, either from industrial processes or naturally by weathering of rocks, they may become available to plants and animals since the pathways for toxic substances such as those within human and animals can be the same as for biologically essential ones.***2. Pollution and Pollutants****2.1 Classification*There is no such thing as a "group" of pollutant substances, since there is the possibility that under specified circumstances any element or compound, whether natural or synthetic, can be a pollutant. So how can we classify a pollutant?It is helpful and even necessary to classify pollutants in order to assess them, but the different kinds of pollutants do not classify easily. Since most biologically active substances may be pollutants in differing circumstances, it is not surprising that there are many ways in which to classify substances as pollutants.Classification may be by:1. Physical nature:gaseous, *e.g.* carbon dioxideliquid,. *e.g.* sewagesolid, *e.g.* domestic wasteenergy, *e.g.* waste heat, noise;2. Biochemical/biological nature:essential, *e.g.* carbonessential but produced in excess, *e.g.* carbon dioxidenaturally occurring, including essential elements, but produced in excess, *e.g.* nitrogen oxidesartificial/synthetic, *e.g.* organochlorines;3. Sector of the environment (pathway) into which released:atmosphereriverssealand;4. Source: for example, from food industry, *e.g.* whey from the dairy industry;5. Pattern of use:for example, from landfilling domestic wastes, *e.g.* methane, leachate;6. Target:vegetation (air and water pollutants)river life (water pollutants and dissolved air pollutants)buildings (corrosion due to air pollutants)7. Effect:hearing damage (noise)illness (bacteria in water supplies)Nuisance/annoyance (noise, odours, visual impact)No ideal or all-embracing classification exists for any one substance and many may be classified in more than one way. All pollutant classifications are arbitrary and to a degree subjective. The easiest classifications to use are those based on chemical and physical properties, which relate readily to a general body of knowledge, but do not necessarily give an indication of the effect on the target.Classification by effect is relatively easy, as the effects are related to the natural classification of living things. A classification based on steps in the source-pathway-target links in the environment is more artificial and difficult to construct as substances are able to freely between environments and few types of human activity have a monopoly as a source of particular pollutants. However, the classification system chosen in each case will always depend on the purpose for which the information is being collected. Figures 1 shows how classifications and interrelationships may be built up. poll.gif **Figure 1**: Pollution classifications

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*2.2 Properties of Pollutants*Whatever classification is agreed, those substances most likely to be troublesome, have certain well-defined features. To assess the likely occurrence and scale of a pollutant it is desirable to evaluate its:a) short and long-term toxicity;b) persistence in the ecosystem/environment;c) characteristics of dispersion and dilution;d) chemical reactions, biodegradation and consequent breakdown or interaction products;e) tendency to bioaccumulate;f) ease of control at emission source;g) scale of manufacture or release.Some of these factors may overlap and trade-offs may be necessary when establishing the overall importance of a pollutant. For example, if a substance is very toxic but disperses rapidly and has low persistence, it may be less dangerous than a relatively non-toxic pollutant which by contrast accumulates in the tissues of a variety of organisms.*a) Toxicity*Toxicity is a measure of the potential damage to life posed by a substance. The more toxic a substance is, the more it must be diluted or rendered innocuous before it may be discharged to the environment.Toxicity need to be assessed in a way which relates dose to targets and time of exposure. Toxicity (like dose) is related to concentration and time of exposure. Criteria (qualitative or quantitative statement of such relationships) are difficult to determine since a high concentration may kill in a short time, but lower concentration either may be lethal over a longer period than is measured, or may not kill but may affect the behaviour or susceptibility stress cumulatively over the lifetime of the organism.Two methods of assessing toxicity are shown in Figure 2. A connection has to be established between the dose given (or taken) and the response to the pollutant. To do this graphically, a dose-response curve may be drawn, as in Figure 2. The response in this case is measured by the percentage of fish killed by receiving a particular dose, expressed in milligrams per kilogram fish body weight. From this the LD50 (the applied lethal dose responsible for killing 50% of the fish population) may be obtained. Where a dose is expressed in terms of concentration, *e.g.* mass per unit volume in surrounding medium, it is possible to record the percentage kill after different periods of exposure to varying levels of the substance. From this graph the LD50 (median lethal concentration) may be obtained. In the case of LD50, a distinction is made between short-term and long-term toxic action. An acute LD50 is measured after the administration of a single dose whereas chronic LD50 refers to longer term action following two or more doses given at different times. Since LD50 values tend to be long-term measurements, they are more comparable to chronic rather than acute LD50 values.

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| ld50.gif |
| Figure 2: Dose-response curve for determination of LD50 |

*b) Persistence*Persistence of a substance in the environment is particularly important but is difficult to test in laboratory conditions. For purposes of assessment, it may be linked to dispersion properties and tendency to biological concentration, so persistence of a substance has a bearing on the rate at which a substance can be released into the environment. The insecticide DDT or the transformer liquid polychlorinated biphenyls (PCBs) are extremely stable, in contrast to organophosphates, which can often be used instead of the organochlorine insecticides and which break down in hours or days is less harmful to the environment than one that is more persistent and breaks down in years or decades.A special category of persistence is that associated with radioactive substances. The half-life of the substance is used as a measure of its radioactive lifetime.*c) Mobility - dispersion and dilution*The solubility of a pollutant in water or its diffusivity (the way it spreads) in air and water affects its local concentration. The ability of sulphur dioxide to disperse in the atmosphere is useful to those who burn fuels with a sulphur content, but the extent to which it can travel in the atmosphere (*e.g.* from UK across continents) can cause long-range pollution problems. On the other hand, oil and water do not mix. A layer of oil lying on the surface of water may be only one or two molecules thick but it can affect the rate at which water takes up oxygen by as much as 50%. Moreover, such a thin film of oil can spread to a considerable extent. When discussing a large area like an ocean or the atmosphere, we should not, however, assume that the capacity for coping with a pollutant is related to size, because the distribution of a pollutant or its accumulation is rarely uniform. *d) Chemical Reactions*The properties of a certain pollutant cannot, however, be considered in isolation. Chemical reaction and breakdown products are important in the environment: the result may be either less dangerous or more so than the original. If a substance is biodegradable it will be broken down quickly, but the products may or may not be harmless. In the case of chlorofluorocarbons (CFCs) they are dangerous because they are not broken down quickly. In addition, two substances together may exhibit either antagonism or synergism.*e) Bioaccumulation*Mention has already been made of the ability of DDT and heavy metals to accumulate within living tissues. DDT and PCBs may be present in the sea at very low concentrations. As low as 1 part in 109, and shellfish that feed by filtering can concentrate these substances to 1 part in 106 or greater. Fish or sea birds may then ingest them as food and over many meals may acquire a body burden of organochlorines that may prove fatal (especially in birds at times of stress when body fat is immobilised).*f) Ease of control at source* Ease of control at source and scale of manufacture must be constantly re-evaluated if assessments are to be realistic. For example, most grit can be readily removed from flue gases, but sulphur dioxide cannot, without a great expense. Thus, if a pollutant cannot be removed readily, special means must be adopted for its disposal to ensure dilution to safe levels.*g) Scale of manufacture or release*The problem of excess carbon dioxide released into the atmosphere by industrial activities is now well publicised, as is that of sulphur dioxide. This problem of scale will also link to the toxicity, persistence and type of substance released. Also, in the case of sulphur dioxide, the quantities produced naturally exceed that from human activities, but at the local scale of artificial production in areas of population causes urban air pollution.*2.3 Environmental Attributes*In order to assess a pollution problem, we must also consider the properties of the system (that is, the environmental attributes of the system) into which pollutants are introduced.A principle environmental attribute is the stability of the system into which the pollutant is discharged. In a watercourse, the aquatic life uses up oxygen, but if a biodegradable waste is added there is an increased rat of biota production, a greater amount of oxygen is used up and the previous stability of the system may break down. Biological stability is an important environmental attribute since we depend on the natural capacity of the environment to take in, break down and recycle wastes.The maintenance of natural biological processes in the environment is fundamental to our continued disposal of wastes, which usually find their way to the seas either down rivers or sewers or from the air as deposits. The seas may not have apparently infinite capacity to process pollutants. The substitution of synthetic organic products for natural ones has considerably intensified environmental pollution.Volume or size, or rate of mixing and temperature distribution are other environmental attributes. Together with intrinsic properties of pollutants, they determine the concentration of pollutants attained, which in turn influences measures taken to control them.Those who have to control a pollutant must realise the danger of possible pollution conversion or cross-media effects. If a solid waste primary pollutant is disposed of by incineration, the gases coming from the chimney may constituent an air pollution problem, so that in this case one pollutant has been converted to another (secondary pollutant).The possibility of accidents will always be present; we need to be able to assess the likelihood and consequences of something going wrong with a technological process. Complete protection against error or foolish actions is impossible, but it is important to consider the possibilities of pollutant escape, and the cost of safe containment, with varying of certainty. The degree of vigilance must be related to the nature of the potential hazard.***3. The Distribution of Pollutants***In trying to classify pollutants, we mentioned the source, pathway and target; this aspect needs to be described in more detail:*3.1 Sources and Pathways*The source of a pollutant may be localised (for example, an industrial effluent from a factory near a river might be discharged into that watercourse) or may be on a more global scale (such as a similar type of effluent discharged from a large industrial complex into an ocean). To lead from the source (emission) to the target (recipient) there are pathways. In the above examples the pathways are in water: one in a river flow, the other in ocean tides and currents. The pathways within the biosphere may also include organisms as a whole, and areas within organisms, such as bloodstreams.As pollutants travel these diverging pathways they may be dispersed and become degraded or diluted, or they may be enhanced by biological or environmental (physical) accumulation, or by reaction with other substances or by synergism. Throughout the your study you will find examples of dilute and disperse or concentrate and contain.*3.2 Dispersion and Dilution*The rate of dispersion, the consequent dilution and the distance which a pollutant travels from source, depend on its characteristics and those of the medium in which it is travelling. All three main parts of the biosphere- air, land, fresh and saline water - vary in their dispersion and dilution rates.Air mixes most rapidly and normally offers speedy dilution and dispersion for gaseous emissions. Air will eventually disperse all pollutants. However, any heavier particles tend to settle out near the source. Also, the climatic conditions will affect the route of travel along the pathway as well as the distance or time of dispersion. Reactions may occur between two constituents to form secondary pollutants such as photochemical smog. Also, synergism may occur, in which two pollutants together have a combined effect which is more than the sum of their separate effects: for example, the mixture of smoke and sulphur dioxide shown to be so deleterious to health in the 1952 London smog.In the sea (and to a lesser extent in lakes and rivers) there is an enormous capacity for dilution and dispersion. The extent and rate are functions of salinity, solubility and diffusion characteristics. In rivers and sea, rather than in lakes, the flow rate is an added dispersion aid. On land, dispersion and dilution occur by seepage and movement into the soil, often with the aid of water, and also to an extent via plants and animals. However, bioaccumulation can occur within the targets themselves.*3.3 Concentration*In the air, concentration may occur locally by the presence of a temperature inversion, in which a polluted layer of air above an area is unable to escape and disperse upwards because of meteorological conditions. There may also be factors of chemical reaction and synergism, which have the effect of concentration rather than dispersion. There is also the possibility of concentration by enclosure, for example, in and around buildings or workplaces where occupational exposure to excessive noise and toxic substances can occur, unless otherwise guarded against.In addition, on land, concentration occurs by containment. For example, in a landfill site where liquid does not drain away into the soil as leachate because the underlying strata prevent seepage, the wastes (pollution) are effectively contained in a natural "pit".*3.4 The Effects of Pollution*Earlier in this introduction one of the classifications of pollutants mentioned is the effect they may have. This can include the effects on humans, livestock or vegetation. A well known case of the effects of pollution was the "Great Smog" of London in 1952, when a combination of smoke, sulphur dioxide and other miscellaneous products of combustion of all fuels in use in London was trapped by meteorological conditions. These conditions led to an estimated 4 000 excess deaths in one week and 8 000 over the next three months. These deaths led to the passing of the Clean Air Act 1956 to control air pollution in the UK, including the low-level emissions from the domestic coal fire. However, affluence and the use of different heating fuels may have done as much in cleaning up urban areas as the implementation of the Clean Air Act 1956. Pollutants can also affect wildlife, crops and livestock or the resources on which life depends. Minamata disease is an example of what can happen when a major food supply in an area is contaminated with a heavy toxic metal compound. Release of toxic effluents whether accidental or not, are continuing to receive publicity as the Environment Agency continues to prosecute.The effects of a pollutant then are ubiquitous. They include not only medical effects but also others such as loss of amenity, metal corrosion or an increase in the house painting - all may be regarded as affecting resources of value to the community. Your course of study intertwines these various aspects. *3.5 The Effects of Noise*Noise is an inevitable "waste" product of all mechanical processes. Since the technological expansion that began during the Industrial Revolution and which has accelerated in industrialised nations since World War II, environmental noise and noise in the workplace have been gradually increasing. More people in factories are becoming exposed to noise levels which can be damaging over a sufficient period of time(noise induced hearing loss) and more traffic and aircraft noise in cities, towns and the countryside (noise nuisance). |
| **Self Assessment**Complete the series of ten questions below based on the material presented above.**SAQ 1** **Which of the following is a valid definition of the term 'pollution'?**Top of FormS:\WASTEDLN\Short Course folder\Env Issues Course\env_issues\images\buttons\checkbox_red.gifThe escape of any substance capable of causing harm to man or any other living organisms supported by the environmentS:\WASTEDLN\Short Course folder\Env Issues Course\env_issues\images\buttons\checkbox_red.gifPollution of the environment means pollution of the environment due to the release (into any environmental medium) from any process of substances which are capable of causing harm to man or any other living organisms supported by the environmentS:\WASTEDLN\Short Course folder\Env Issues Course\env_issues\images\buttons\checkbox_red.gifPollution may be caused by any substance whether natural or industrially produced, or by waste energyS:\WASTEDLN\Short Course folder\Env Issues Course\env_issues\images\buttons\checkbox_red.gifAll of the aboveBottom of FormTop of FormBottom of Form**SAQ 2****Which three major biologically essential elements are obtained from the atmosphere?**Top of FormS:\WASTEDLN\Short Course folder\Env Issues Course\env_issues\images\buttons\checkbox_red.gifCarbon, Hydrogen and OxygenS:\WASTEDLN\Short Course folder\Env Issues Course\env_issues\images\buttons\checkbox_red.gifCarbon, Sodium and OxygenS:\WASTEDLN\Short Course folder\Env Issues Course\env_issues\images\buttons\checkbox_red.gifCarbon, Hydrogen and PhosphorousS:\WASTEDLN\Short Course folder\Env Issues Course\env_issues\images\buttons\checkbox_red.gifCalcium, Hydrogen and OxygenBottom of FormTop of FormBottom of Form**SAQ 3****Heavy metal elements and their salts are physiologically toxic. Which of the following is *not* a heavy metal?** Top of FormS:\WASTEDLN\Short Course folder\Env Issues Course\env_issues\images\buttons\checkbox_red.gifMercuryS:\WASTEDLN\Short Course folder\Env Issues Course\env_issues\images\buttons\checkbox_red.gifSodium ChlorideS:\WASTEDLN\Short Course folder\Env Issues Course\env_issues\images\buttons\checkbox_red.gifLeadS:\WASTEDLN\Short Course folder\Env Issues Course\env_issues\images\buttons\checkbox_red.gifCadmiumBottom of FormTop of FormBottom of Form**SAQ 4****Which of the following is the easiest method for the classification of pollution and pollutants?**Top of FormS:\WASTEDLN\Short Course folder\Env Issues Course\env_issues\images\buttons\checkbox_red.gifSector of the environment (pathway) into which it is releasedS:\WASTEDLN\Short Course folder\Env Issues Course\env_issues\images\buttons\checkbox_red.gifChemical/physical propertiesS:\WASTEDLN\Short Course folder\Env Issues Course\env_issues\images\buttons\checkbox_red.gifPattern of useS:\WASTEDLN\Short Course folder\Env Issues Course\env_issues\images\buttons\checkbox_red.gifEffectBottom of FormTop of FormBottom of Form**SAQ 5****Which of the following statements is *incorrect*?**Top of FormS:\WASTEDLN\Short Course folder\Env Issues Course\env_issues\images\buttons\checkbox_red.gifToxicity is a measure of the potential damage to life posed by a substance.S:\WASTEDLN\Short Course folder\Env Issues Course\env_issues\images\buttons\checkbox_red.gifPersistence of a substance in the environment is particularly important and is easy to test under laboratory conditions.S:\WASTEDLN\Short Course folder\Env Issues Course\env_issues\images\buttons\checkbox_red.gifIn order to assess a pollution problem, we must also consider the properties of the system into which pollutants are introduced.S:\WASTEDLN\Short Course folder\Env Issues Course\env_issues\images\buttons\checkbox_red.gifThe solubility of a pollutant in water or its diffusivity in air and water affects its local concentration.Bottom of FormTop of FormBottom of Form**SAQ 6****What does the term LD50 represent?**Top of FormS:\WASTEDLN\Short Course folder\Env Issues Course\env_issues\images\buttons\checkbox_red.gifAn LD50 value is the amount of a solid or liquid material that it takes to kill 5% of animals in one dose.S:\WASTEDLN\Short Course folder\Env Issues Course\env_issues\images\buttons\checkbox_red.gifAn LD50 value is the amount of a solid or liquid material that it takes to kill 15% of animals in one dose.S:\WASTEDLN\Short Course folder\Env Issues Course\env_issues\images\buttons\checkbox_red.gifAn LD50 value is the amount of a solid or liquid material that it takes to kill 25% of animals in one dose.S:\WASTEDLN\Short Course folder\Env Issues Course\env_issues\images\buttons\checkbox_red.gifAn LD50 value is the amount of a solid or liquid material that it takes to kill 50% of animals in one dose.Bottom of FormTop of FormBottom of Form**SAQ 7****Which of the following is *not* a characteristic for the dispersion and dilution of pollutants in air?**Top of FormS:\WASTEDLN\Short Course folder\Env Issues Course\env_issues\images\buttons\checkbox_red.gifMixes most rapidly and normally offers speedy dilution and dispersion for gaseous emissions. S:\WASTEDLN\Short Course folder\Env Issues Course\env_issues\images\buttons\checkbox_red.gifSynergism may occur.S:\WASTEDLN\Short Course folder\Env Issues Course\env_issues\images\buttons\checkbox_red.gifDispersion and dilution occur by seepageS:\WASTEDLN\Short Course folder\Env Issues Course\env_issues\images\buttons\checkbox_red.gifHeavy particles tend to settle out near sourceBottom of FormTop of FormBottom of Form**SAQ 8****The concentration of a pollutant is likely to increase:**Top of FormS:\WASTEDLN\Short Course folder\Env Issues Course\env_issues\images\buttons\checkbox_red.gifWhere a polluted layer of air above an area is unable to escape and disperse upwards due to meteorological conditions *i.e.* a temperature inversionS:\WASTEDLN\Short Course folder\Env Issues Course\env_issues\images\buttons\checkbox_red.gifDue to chemical reactions and synergismS:\WASTEDLN\Short Course folder\Env Issues Course\env_issues\images\buttons\checkbox_red.gifWhen a pollutant is contained in an area *e.g.* landfill siteS:\WASTEDLN\Short Course folder\Env Issues Course\env_issues\images\buttons\checkbox_red.gifAll of the aboveBottom of FormTop of FormBottom of Form**SAQ 9****In which year was the great 'Smog of London' which led to 4000 deaths in one week and a further 8000 over the next three months?** Top of FormS:\WASTEDLN\Short Course folder\Env Issues Course\env_issues\images\buttons\checkbox_red.gif1951S:\WASTEDLN\Short Course folder\Env Issues Course\env_issues\images\buttons\checkbox_red.gif1952S:\WASTEDLN\Short Course folder\Env Issues Course\env_issues\images\buttons\checkbox_red.gif1953S:\WASTEDLN\Short Course folder\Env Issues Course\env_issues\images\buttons\checkbox_red.gif1954Bottom of FormTop of FormBottom of Form**SAQ 10****The great Smog of London led to new legislation to control air pollution in the UK. In which year was the Clean Air Act passed?**Top of FormS:\WASTEDLN\Short Course folder\Env Issues Course\env_issues\images\buttons\checkbox_red.gif1954S:\WASTEDLN\Short Course folder\Env Issues Course\env_issues\images\buttons\checkbox_red.gif1955S:\WASTEDLN\Short Course folder\Env Issues Course\env_issues\images\buttons\checkbox_red.gif1956S:\WASTEDLN\Short Course folder\Env Issues Course\env_issues\images\buttons\checkbox_red.gif1957Bottom of Form |