NOISE POLLUTION

By

Muhammad Asif[1]

There are many definitions of noise; however, the most common definition is “Unwanted Sound”.

Noise pollution (or environmental noise) is displeasing human or machine-created sound that disrupts the activity or balance of human or animal life. A common form of noise pollution is from transportation, principally motor vehicles.

1-Sources of noise

The source of most noise (around the world) is transportation systems, which includes motor vehicle noise, aircraft noise and rail noise. Poor urban planning may give rise to noise pollution? side by side industrial and residential buildings can result in noise pollution in the residential area.

Other sources are car alarms, office equipment, factory machinery, construction work, appliances, power tools, lighting hum and audio entertainment systems.

2-Human health effects

This unwanted sound can damage physiological and psychological health. Noise pollution can cause annoyance and aggression, hypertension, high stress levels, tinnitus, hearing loss, sleep disturbances, and other harmful effects. Furthermore, stress and hypertension are the leading causes to health problems, whereas tinnitus can lead to forgetfulness, severe depression and at times panic attacks.

Chronic exposure to noise may cause noise-induced hearing loss. Older males exposed to significant occupational noise demonstrate significantly reduced hearing sensitivity than their non-exposed peers.

Noise pollution is also a cause of annoyance. A 2005 study by Spanish researchers found that in urban areas, households are willing to pay approximately four Euros per decibel per year for noise reduction.

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3-Environmental effects

Noise can have a detrimental effect on animals by causing stress, increasing risk of mortality by changing the delicate balance in predator / prey detection and avoidance, and by interfering with their use of sound in communication especially in relation to reproduction and in navigation. Acoustic overexposure can lead to temporary or permanent loss of hearing.

An impact of noise on animal life is the reduction of usable habitat that noisy areas may cause, which in the case of endangered species may be part of the path to extinction. One of the best known cases of damage caused by noise pollution is the death of certain species of beached whales, brought on by the loud sound of military sonar.

Noise also makes species communicate louder, which is called Lombard vocal response. Scientists and researchers have conducted experiments that show whales' song length is longer when submarine-detectors are on. If creatures don't "speak" loud enough, their voice will be masked by anthropogenic sounds. These unheard voices might be warnings, finding of prey, or preparations of net-bubbling. When one species begins speaking louder, it will mask other species' voice, causing the whole ecosystem to eventually speak louder.

Zebra finches become less faithful to their partners when exposed to traffic noise. This could alter a population's evolutionary trajectory by selecting "sexy" traits, sapping resources normally devoted to other activities and thus lead to profound genetic and evolutionary consequences.

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Industrial Noise

The sound of industry, growing in volume over the years, have heralded not only technical and economic progress, but also an ever increasing incidence of hearing loss and other noise-related hazards to exposed employees. Noise is not a new hazard. Indeed, noise-induced hearing loss was observed centuries ago. In 1700, Ramazzini in “De Morbis Artifium Diatriba” described how workers who hammer copper "have their ears so injured by that perpetual din that the workers of this class become hard of hearing, and if they grow old at this work, they become complete deaf."

Before the Industrial Revolution; however, comparatively few people were exposed to high levels of noise in the workplace. The advent of steam power during the Industrial Revolution first brought general attention to noise as an occupational hazard. Workers who fabricated steam boilers were found to develop hearing loss in such numbers that the malady was dubbed boilermakers' disease. The increasing mechanization that has occurred in all industries and in most trades has since aggravated the noise problem. Noise levels in the workplace, particularly those maintained in mechanized industries, are likely to be more intense and sustained than any noise levels experienced outside the workplace. Basically, this involves assessing the extent of the noise problem, setting objectives for a noise abatement program, controlling exposure to excessive noise and monitoring the hearing of exposed employees.

Properties of sound

Sound can be defined as any pressure variation (in air water, or some other medium) that the human ear can detect. The number of pressure variations over time is called the frequency of sound. Frequency is measured in cycles per second, or hertz (Hz).

Sound can be defined as a stimulus that produces a sensory response in the brain. The perception of sound resulting in the sensation called hearing is the principal sensory response in the brain. The perception of sound sensory response; however under certain conditions, additional subjective sensations ranging from pressure in the chest cavity to actual pain in the ears can be produced. These are certain effects produced by sounds that appear to be universally undesirable for all people. These effects include the following:

- The masking of wanted sounds, particularly speech
- Auditory fatigue
- Damage to hearing
- Annoyance

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Noise

What we call noise is usually sound that bears no information and whose intensity usually varies randomly in time. The word noise is often used to mean unpleasant sound that the listener does not want to hear. Noise interferes with the perception of wanted sound and is likely to be physiologically harmful.

Noise does not always have particular physical characteristics that distinguish it from wanted sound. No instrument can distinguish between sounds and noise only human reaction can.

A variety of methods have been devised to relate objective physical measurements of sound to subjective human perception. The purpose of this section is to outline both the objective physical properties of sound and its important subjective aspects.

The term sound usually refers to the form of energy that produces a sensation perceived by the sense of hearing in humans etc., whereas vibration usually refers to non-audible acoustic phenomena that are recognized by the tactile experience of touch or feeling. However, there is no essential physical difference between the sonic and vibratory forms of sound energy.

The generation and propagation of sound are easily visualized by means of a simple model. Consider a plate suspended in midair. When struck, the plate vibrates rapidly back and forth. As

the plate travels in either direction it compresses the air causing a slight increase in its pressure. When the plate reverses direction, it leaves a partial vacuum or rarefaction of the air.
These alternate compressions and rarefactions cause small but repeated fluctuations in the atmospheric pressure that extend outward from the plate. When these pressure variations strike an eardrum they cause it to vibrate in response to the slight changes in atmospheric pressure. The disturbance of the eardrum is translated into a neural sensation in the inner ear and is carried to the brain where it is interpreted as sound.

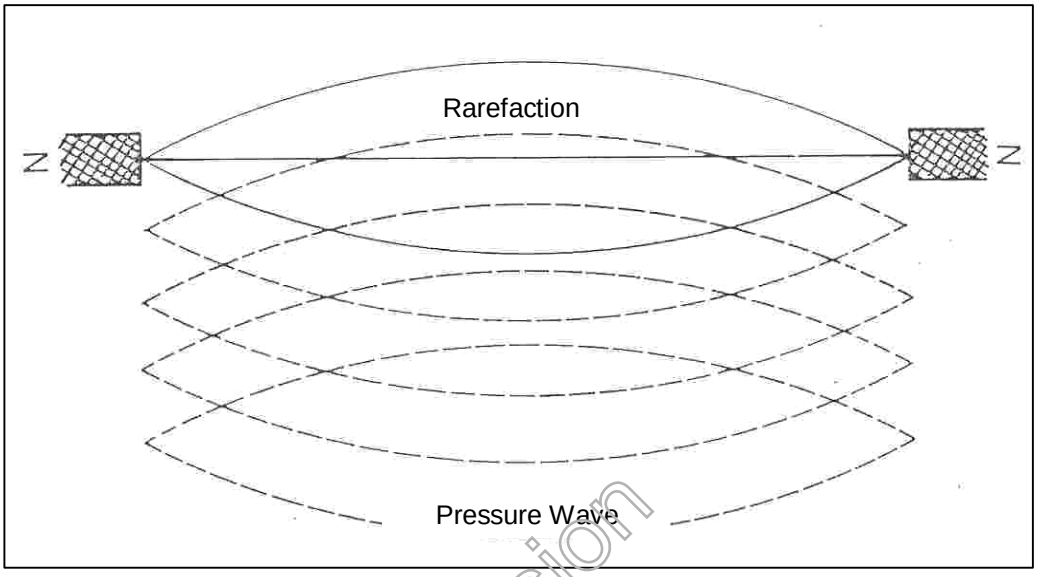


Fig 1

As shown in the Figure 1 that the vibrating plate moves back and forth, it compresses the air in the direction of its motions. When it reverses direction it produces a partial vacuum or rarefaction imparting energy to the air which radiates away from the plate as sound.

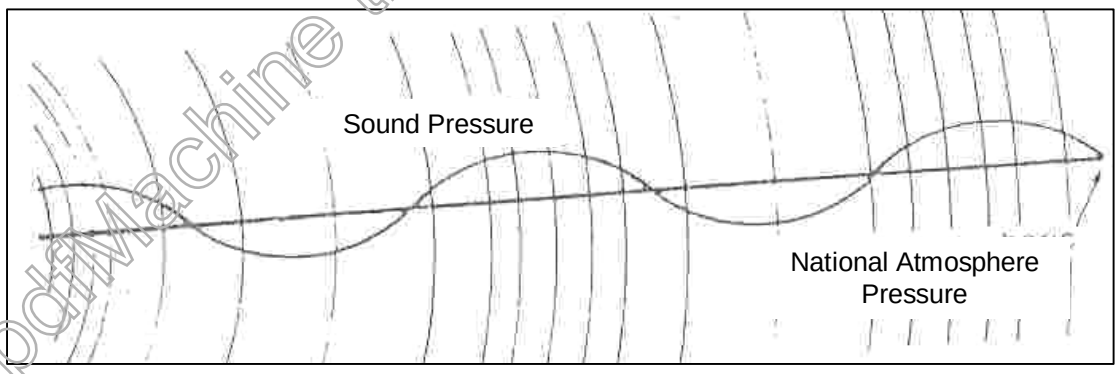


Fig 2

As shown in the Figure 2 that air is an elastic medium and behaves as if it were a succession of adjoining particles. The resulting motion of the medium is known as wave motion and the instantaneous form of the disturbance is called a sound wave.

Risk Factors

If the ear is subjected to high levels of noise for a sufficient period of time some loss of hearing will occur. There are many factors that affect the degree and extent of hearing loss, including the following:

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- The intensity of the noise (Sound pressure level)
- The type of noise (Frequency spectrum)
- The period of exposure each day (worker's schedule per day) the total work duration (years of employment)
- Individual susceptibility
- The age of the worker
- Coexisting hearing loss and ear disease
- The character of the surroundings in which the noise is produced
- The distance from the source
- The position of ear with respect to sound waves

The first four factors are the most important and they are called **noise exposure factors**. Thus, it is necessary to know not only how much noise is present, but also what kind of noise it is and its duration.

Because of the complex relationship of noise and exposure time to threshold shift (reduction in hearing level) and its many possible contributory causes, the criteria designed to protect workers from hearing loss took many years to develop and establish.

It can be stated that 20 percent of the general population between the ages of 50 and 59 experience hearing loss without having had any exposure to industrial noise them groups of workers exposed to steady-state industrial noise over a working lifetime showing a greater increase in the incidence of hearing loss.

Impact-type noise:
Impact-type noise is a sharp burst of sound, in which sophisticated instrumentation is necessary to determine the peak levels of this type of noise. Noise types other than steady ones are commonly encountered. In general sound repeated more than once per second can be considered as steady. Impulsive or impact noise such as that made by hammer blows or explosions is generally less than one half second in duration and does not repeat more often than once per second. Employees should not be exposed to impulsive or impact noise that exceeds peak sound pressure level of 140 Db.

Compliance with these provisions requires the use of and instrument capable of measuring UN weighted peak sound pressure level. These analyzers are either integral with or used in conjunction with a sound level meter.

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Decibel Levels of Common Noise Sources
Many different properties affect the noise level of a specific source type. For example the lawn mowers may have three different noise levels because of differences in each specific piece of equipment. Noise level also depends on the distance from the noise source and the attenuation of the surrounding equipment.

Decibel Levels of Common Noise Sources

Sound Pressure Level (Dba)	Noise Source
140 ----------	Jet Engine (at 25 meters)
130 ----------	Jet Aircraft (at 100 meters)
120 ----------	Rock and Roll concert
110 ----------	Pneumatic Chipper
100 ----------	Jointer/ Planer
90 ----------	Chainsaw
80 ----------	Heavy Truck Traffic
70 ----------	Business Office
60 ----------	Conversational Speech

50 ---------- Library
40 ---------- Bedroom
30 ---------- Secluded Woods
20 ---------- Whisper

Using Decibels

Addition and subtraction of decibels is often necessary for estimating total noise level or background noise. Because decibels are measured using a logarithmic scale and so, conventional linear mathematics can not be used. The most convenient way to perform simple arithmetic functions involving logarithmic measurements is to use doubling rules. These rules provide an accurate estimate of the effect distance and multiple sources have on measured sound pressure level.

Distance Attenuation Estimations

When the distance is doubled from a Line source the sound level decreases three decibels. (Fig 3)

Example: if a sound level is: 70 decibels at 50 feet it will be
67 decibels at 100 feet, and
64 decibels at 200 feet

When the distance is doubled from a Point source the sound level decreased six decibels.

Example: if a sound level is: 95 decibels at 50 feet it will be
89 decibels at 100 feet it will be
83 decibels at 200 feet

Distance Attenuation of Noise Levels

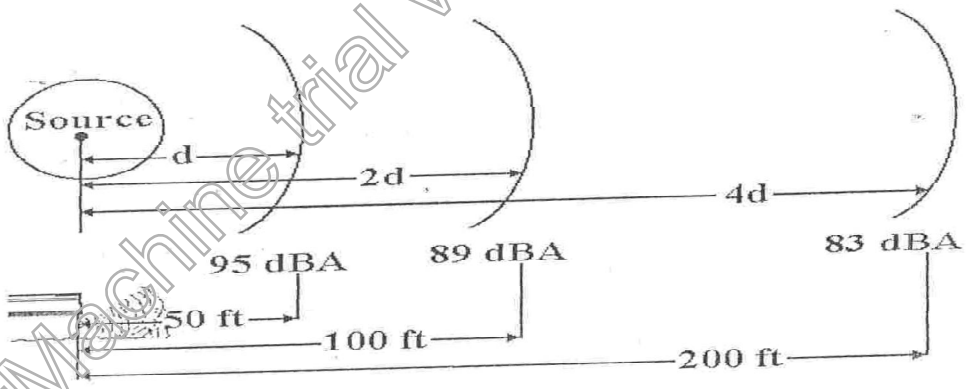


Fig 3

Addition and subtraction of Decibel Levels

In many situations pertaining to noise control and monitoring, it is very useful to be able to add and subtract levels. A double of sound energy yields an increase of three decibels. It is important to note the characteristics of logarithmic addition or subtraction of decibel levels.

Noise dosimeter:

A noise dosimeter (American) or noise dosemeter (British) is a specialised sound level meter intended specifically to measure the noise exposure of a person integrated over a period of time; usually to comply with Health and Safety regulations such as the EU Directive 2003/10/EC, or the equivalent American OSHA rules.

Measuring industrial noise:

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In many factory noise situations, a sound level meter is a perfectly suitable device to check compliance with OSHA or EU requirements. If a Class 2 sound level meter is used, or what used to be called a "Type 2," with due allowance made for the measurement uncertainty, and in any part of particular premises there is no noise level above say 80 dB(A)S, (80 decibel A-frequency and S-time-weighted), it is clear that every worker will be below a limit set at say 85 dB(A) and there is no need to use more complex measurement devices. However, if it is suspected or known that sound levels above 85 dB(A)S are found, a dosimeter was traditionally the usual instrument required - at least in the USA and its sphere of influence.

Variations in legal requirements:

The five main parameters that were commonly different in different political entities were:

- Threshold
- Criterion level
- Exchange rate
- Exponential or linear integration
- 'Head-on' or random incidence calibration

There were of course others, such as the single event maximum level, the peak value etc. To reduce the variations of instrument required to be manufactured, some commercial companies made complex "Universal" units where all these things could be selected by the user. As measuring noise was not well understood, such complexity clearly militated against accurate results and many anecdotal stories give examples of huge errors resulting; as very few unqualified users understand the complex issues involved.

International standards

The international body that specifies the technical requirements of such instruments as sound level meters and dosimeters is the International Electro-technical Commission (IEC) based in Geneva; whereas the method of their use is normally given in an ISO publication. However, in any particular political region, local laws apply as the IEC and ISO publications only have the status of "recommendations" and so countries could - and did - have their own sets of rules - many of which were technically flawed and in some cases scientifically impossible. Every new regulation thus made the concept of "% dose" more meaningless. The "100%" dose was different in different countries, but many users did not understand this and would buy low cost USA built dosimeters where the American "100%" was not correct for their local regulations and usually very much under-estimated the noise exposure.

The permitted levels reduced

During the 1980s and 1990s many workers - led by Scandinavia - determined that the '90dBA for 8 hours' limit was far too high and an unacceptable number of workers would be damaged at these levels, so a level of 85 dB(A) for 8 hours was felt to be a better criterion. Even later the EU reduced the limits still further to the 80 dB(A) we have today, as given in the UK's "The Control of Noise at Work Regulations 2005.". These regulations follow closely the EU Directive 2003/10/EC, normally called the Physical Agents Directive.

A further complication for the sound level meter designer was that it was realised that a single very high noise peak could instantaneously damage hearing, so a limit was originally set by the then European Community so that no worker should ever be exposed to an rms acoustic pressure of more than 200 Pa - equating to 140 dB re 20 □Pa - and that this should be measured using an instrument with no frequency weighting. This while a good idea, was patent nonsense as 200 Pa could be generated by trains going through tunnels, closing a door, in fact many everyday things could cause such a pressure wave below the frequencies that could be heard or could cause hearing damage. Accordingly C-frequency-weighting was specified to measure the peak level as this has a flat frequency response between 31 Hz and 8 kHz. However, this missed a significant amount of important energy and a new frequency weighting of 'Z' (zero) weighting was specified in IEC 61672 : 2003 that has a flat response from at least 20 Hz to10 kHz.

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The 21st century devices

The next technology breakthrough came when in the 1990s the United Kingdom Department of Trade and Industry awarded a SMART grant to Cirrus Research to design an ultra-miniature dosimeter. It was to be so small and light that it would not affect the worker and as well was to have no microphone cable. The resulting device, the first true dosibadge - was a twin channel device able to meet all the requirements of the European Directive and also the market need for data storage. The device had no internal display nor any controls, so workers would not be tempted to try and 'modify' the readings; instead the data was transmitted and the device controlled by an infra-red link .

Today, such devices are available from several manufacturers - at least one with a full Intrinsic Safety certificate for use in hazardous atmospheres. Some sophisticated ones have extra channels to store data on the state of the battery, any 'out of range' signals and some are able to be used on the USA OSHA as well as EU equal energy rules. Others have a "Time History" store, where the exposure minute by minute is stored for the full working shift, allowing Health and Safety Officers to pinpoint the exact time of any high energy noise and assist in determining the cause. The most recent design innovation for noise dosimeters offers a multiple-point approach to assess workers daily noise exposure. This approach relies on the deployment of a set of dosimeters that have wireless (Bluetooth) communication with a handheld device such as PDA.

STEPS TAKEN BY KAPCO FOR NOISE CONSERVATION PROGRAM.

KAPCO ACHIEVEMENTS FOR NOISE POLLUTION CONTROL:

KAPCO is IMS certified company having certification of three international standards i.e. ISO 9001:2000 (Quality Management System), ISO 14001:2004 (Environmental Management System) and OHASS 18001 (Safety Management System).

KAPCO has established Environmental Laboratory which works round the clock with highly qualified and experienced professionals. KAPCO laboratory is fully equipped with high tech equipments like Noise dosimeter etc.

1) KAPCO managed for Noise monitoring programs for all areas of the power plant.
2) Noise level monitoring is carried out on monthly basis at all over the power plant. There are about 28 areas where noise level is being monitored and circulating to concerned quarters for remedial actions.
3) Noise conservation lectures are delivered to all employees including contractors staff on monthly basis.
4) Engineering solutions were performed on the de-aerator of steam turbine unit 9 & 10 in order to reduce noise levels.
5) Steam leakages that icreases noise level are attended on priority basis.
6) All concerned staff and officers are provided required PPE's (ear muff , ear plug) who are working in high noise level areas.
7) Demonstration was performed for high noise level areas with signs and monograms.
8) All concerned staff and officers are trained to use PPE's.

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References

EU Directive 2003/10/EC, normally called the Physical Agents Directive.
Occupational Safety and Health Act. Code of Federal Regs, Title 29, Chapter XVII, Part 1910.
IEC 61252 :1993 - Acoustics - Personal Sound Exposure Meter
Wallis A.D. & Krug R.W. "A data storing dosimeter" Proc IOA Vol 11 part 9 101-106 Nov 1989.

Glossery

Annoyance	Irritation, Frustration
Hypertension	High blood pressure

Zebra Finches	A type of bird
Traits	Personality, Qualities
Ramazzini	An Italian Physician & Philosopher
De Morbis Artificium Diatriba	Book
Perpetual din	Permanent noise
Abatement	Reduction
OSHA	Occupational Safety & Health Administration

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CONSTRUCTION DISPUTE RESOLUTION : A CHANGING LANDSCAPE

By

Ir. Chong Thaw Sing[1]

A construction project even if it is a repetition of the same design in a new location is largely considered to be prototypical in nature. As a prototype, the constructed structure is never tested for its performance. Hence, differences in opinion as to its execution or performance are common causes of different views in the construction industry. Many of these differences eventually developed into full-blown disputes requiring the intervention of neutrals.

For decades, arbitration and litigation are the two commonly used forms of construction dispute resolution. The choice of these two methods of resolving construction disputes stems from the fact that the decisions of the arbitrator or a judge, though appealable in higher court, could not be re-litigated by a dissatisfied litigant in another forum. The application of the legal doctrine of res judicata[2] shuts a litigant from starting a court action or arbitration on the same issues, thereby putting a finality to the dispute.

Today, with the increase in globalised commercial activities, the untold advantage of arbitration (apart from being able to choose the preferred tribunal in arbitration) is the availability under the New York Convention 1958 of an avenue to enforce arbitrators' awards in more than 140 signatory countries.

Parallel to this development, the dispute resolution fraternity has proposed an increasing use of other intermediate dispute resolution process to save cost and time, before attempting arbitration or litigation. In many international contracts and some standard form contracts, multi-step dispute resolution clause has been routinely included in the contract. This form of multi-step dispute resolution clause is commonly known as 'forced escalation clause'. Here, the disputants who are unable or refuse to settle their disputes are forced to move to the next level of a more formal, more adjudicative and more expensive form of resolution method.

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MULTI-STEP DISPUTE RESOLUTION CLAUSE

In many common law jurisdictions, a typical multi-step Alternative Dispute Resolution (ADR) clause includes the initial negotiation, followed in order by mediation or conciliation, expert determination or adjudication before the parties are forced to resolve their dispute in arbitration or litigation. The dispute resolution processes become more adversarial and adjudicative as it progresses up the ADR chain.

Earlier, there were some doubts whether an agreement to negotiate is enforceable until a decision in Watford v Miles[3] where the House of Lords held that an agreement to negotiate is not enforceable in law. However, in Australia, Justice Giles[4] took a narrower stand in holding that an agreement to submit any dispute to a conciliator before arbitration was enforceable if the parties agree to conciliate an already identified issue prior to issuance of the notice of dispute.

In this case, Giles J said the clause on conciliation is enforceable because a previous letter had identified the issues to be resolved in the conciliation process. The moot point is, will the Australian court rule as it did if the parties have not had prior agreement on the issues to be conciliated? It is submitted that the Australian court would probably have followed the House of Lords' decision in Watford v Miles and rule the clause unenforceable for uncertainty.

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1. MIEM, P. Eng.
2. Bulletin Editor's Note : Latin, meaning that no further adjudication of an issue or dispute is possible as it has already been authoritatively and definitively settled by another adjudication.
3. (1992) 1 All ER 453.
4. Hooper Baille Associated Ltd v Natcon Group Pty Ltd (1992) 28 NSWLR 194.

Whilst a multi-step dispute resolution clause may be unenforceable for uncertainty due to poor drafting, such intermediate dispute resolution process has proven to be an effective cost saving device in the hands of experienced professionals. Mediator Philip Naughton, QC, for example, facilitated a resolution of a multi-million pounds claim dubbed "mega-mediation" in just two days as opposed to the planned six weeks trial involving multiple parties, layers of insurers three solicitors firm and a dispute running into four years. In another case involving the collapse of the canopy in Aberdeen, Hong Kong, the 10-years-long running civil litigation was resolved in five and a half months of mediation.

Quite clearly, intermediate dispute resolution process has served to expedite the dispute resolution process and minimize cost notwithstanding the difficulties of lack of clarity of the end of one tier and the beginning of another, usually brought about by poor drafting of the multi-step dispute resolution clause. Today, many standard form contracts including FIDIC, JCT 98, ICE 6th Edition and our PAM 2006 have adopted some form of multi-step dispute resolution process.

ADJUDICATION

In 1972, Lord Denning made a historic decision for the construction industry when he stated that:

"There must be cash flow in the building trade. It is the very lifeblood of the enterprise".

His sympathy for the contractor / subcontractor is evident in this statement :

"He is out of pocket ; probably has an overdraft at the bank. He cannot go on unless he is paid for what he does. The main contractor is in the like position. He has to pay his men and buy his material. He has to have cash from the employer, otherwise he will not be able to carry on. So once the Architect gives his certificate, they must be honoured all down the line".[1]

Lord Denning quite clearly wants the contractor / subcontractor's interim payment certificates to be paid without set off from employer / contractor. His rationale for wanting interim payment certificates to be honoured without allowing the employer the right of a set off is encapsulated in his previous statement.

Shortly after Lord Denning's landmark decision, the Federal Court[2] in *Bandar Raya Developments Bhd v Woon Hoe Kan & Sons Sdn Bhd* echoed Lord Denning's view where Ong Hock Sim FJ decided that, *"a debt due under an interim payment certificate (is) a debt of a class which ought not be allowed to be made the subject of set-off or counterclaim".*

Lord Denning's brave decision did not find favour with the House of Lords, it was quickly overruled in Gilbert-Ash[3] in 1974. However, in Malaysia, we have had to wait another 20 years before the Federal Court in *Pembenaan Leow Tuck Chui v Dr Leela's Medical Centre Sdn Bhd*[4] overruled its own decision of 1974. Edgar Joseph Jr said :

(W)ith all due respect to Lord Denning, for the reasons stated in the House of Lords' case of Gilbert-Ash, we are unable to agree with him that an interim certificate or indeed any certificate issued by an architect or engineer pursuant to provisions of the RIBA and other known forms of building contracts and subcontracts are to be virtually treated as cash, like bill of exchange. In our view, therefore, there is no special rule of construction operating in the building contract cases, such as was advocated by Lord Denning by way of obiter dictum in Dawnays case, which lays down that contracts with provision for payment of certificates negative the ordinary common law right to set off enunciated in Mondel v Steel (1841) 8 m & W 871 at P. 872.

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1. Dawnay v Minter (1971) 1 WLR 1205.
2. (1972) MLJ 75 at P. 76.
3. Gilbert-Ash (Northern) Ltd v Modern Engineering (Bristol) Ltd (1974) AC 689.
4. (1995) 2 MLF 57.

This decision of the Federal Court has unwittingly encouraged unscrupulous employers or contractors to use the right to set off as an excuse to reduce or negate the interim payment certificate amount due to a contractor / subcontractor thus plunging some contractor / subcontractor into cash flow crisis. Such unreasonable practice has, therefore, become the source of numerous disputes in construction industry.

To solve the cash flow problem in the construction industry, England, in 1996, led the revolution of the dispute resolution landscape. The Housing Grant and Construction Regeneration Act 1996 (HC-CRA) was introduced pursuant to Sir Michael Latham's report "Constructing the Team" which studied exhaustively the malaises afflicting the UK construction industry. HGCRA introduced the mandatory statutory adjudication as an intermediate dispute resolution process to redress growing contractor / subcontractors' complaints of debilitating cash flow caused by employer / contractor's unjust withholding of interim payments.

The qualified success of adjudication in UK has served to encourage others to study the feasibility of introducing such legislature in their jurisdiction. In fact, several countries, i.e. New South Wales in Australia in 1999, New Zealand in 2002 and Singapore in 2004, quickly adopted statutory adjudication in varied forms. Adjudication has since been touted by the construction industry as the most "appropriate" mechanism for the contractors / subcontractors to redress their problems of cash flow precipitated by an unreasonable withholding of payments by the employer / contractor.

After adjudication was introduced in the UK some 15 years ago, Malaysia is once again at a crossroad, mulling over the enactment of some form of adjudication mechanism. At this juncture, the proposal has generated many, sometimes heated, discussions as to the pros and cons of the introduction of adjudication and the form it should take. Until a consensus is reached, I am sure the proponents and the opponents of adjudication will continue to debate the merits and demerits of such legislation in Malaysia.

Perhaps it would be helpful to understand the rationale as to why the Australian state of New South Wales (NSW) introduced adjudication. The NSW Minister responsible for introducing the Bill in the NSW State Legislative Assembly had wholeheartedly echoed Lord Denning's views on cash flow in the construction industry during its First Reading. The Hansard in the NSW State Legislature recorded this statement by the Minister :

"Cash flow is the life blood of the Construction Industry. Final determination of disputes is often very time consuming and costly. We are determined that, pending final determination of all disputes, contractors, sub-contractors should be able to obtain a prompt interim payment on account as always intended under the Act.[1]"

It is clear that this Australian state had enacted this intermediate dispute resolution process believing that it could solve the cash flow crunch in the construction industry. Is Malaysia ready to join this select group of common law countries in introducing this intermediate dispute resolution process? The construction industry will surely be awaiting with abated breath.

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ARBITRATION

Construction projects are often inundated with paper trails. The huge amount of documents generated by a construction project naturally becomes the documentary evidence in construction arbitration. It is not uncommon in construction arbitration to have truck loads or voluminous amount of documents being transported to the proceeding each time the tribunal sits.

Although in the past, arbitral tribunal often order full discovery or disclosure of documents, such is not the case today. The practice of submitting voluminous documents is no longer an indication of the strength of the case but quality of the evidence is. The English Court of Appeal

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1. NSW Legislation Assembly Hansard, 12 November 2002, at 6541.

in *Glaxo Group Ltd. v Dowelhurst Ltd,*[1] issued a salutary warning to the parties and the lawyers alike who failed to consider what documents are actually needed to determine a dispute, Jacob L J said :

"I do not wish to part with this case without entering a strong protest about the bundles. We were originally sent 50 bundles of document. After the court made inquiries as to what they were for, many of them were taken away. We were nonetheless left with half. Of these, by my calculation, ten were never opened. In the case of others a page or two were looked at. No attempt was made to comply with Practice Direction which requires core bundle of essential document . . . the consequence of all this undoubtedly made the hearing more cumbersome and the writing of judgment more difficult".

The English Court of Appeal's warning is a timely reminder to the parties and the solicitors alike to refrain from swamping the tribunal with a huge load of documents. On the contrary, the issues could be successfully argued using the core bundles as the primary evidence rather than a voluminous bundle of documents.

Subcontracting is an indispensable part of a construction contract. Generally, 70% of the work in a construction project is executed by subcontractors. Frequently, disputes between the contractor and the subcontractors spawned disputes between the employer and the contractor. The common pitfalls in the arbitral processes between the contractor and subcontractor, and between the employer and the contractor on identical issues by different tribunals are adverse decisions by the two tribunals on one party, usually the contractor, being the common party.

It is conceivable that such anomaly could occur because evidence adduced in one tribunal cannot be imported into another tribunal even if they are dealing with the same issues between different parties. Such prohibition due to the law on privacy and confidentiality of arbitration proceedings could skew the tribunal's decisions. In such a case, the solution is for the parties to invoke Section 40 of the Malaysian Arbitration Act 2005 to consolidate the two arbitrations into one proceeding.

Hence, in a project where multiple subcontractors are involved in the work, it is wise for the subcontracts to include a clause agreeing to consolidate arbitrations between the employer and the contractor as well as between the contractor / subcontractor. Alternatively, the parties could adopt arbitration rules which allow the arbitration to be consolidated. SIAC arbitration in Rule 8 allows multi-party appointment of arbitrators.

CONCLUSION

The dispute resolution landscape in the construction industry has metamorphosed over years to include several intermediate methods of dispute resolution in addition to arbitration and litigation. It was thought that these intermediate processes will be more cost effective and expeditious in resolving construction disputes.

The introduction of statutory adjudication has similarly altered the landscape of dispute resolution in the construction industry in the UK, Australia, New Zealand and Singapore. The varied form of adjudication processes introduced in the UK, Australia (NSW), New Zealand and Singapore have reportedly been effective in improving cash flow in the construction industry, but how the process will impact the Malaysian construction industry will remain a moot point for now.

In the arbitration process, many changes in the procedures have been instituted to better manage the process, thereby reining in on the cost and time factor. For example, the parties should not swamp the tribunal with voluminous documents, rather they should utilize core bundle to prove the case. Similarly, the disadvantage of arbitration in including a third party in the proceedings could now be effectively circumvented by using the consolidation option in our arbitration law.

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1. (2004) All ER 129.

(Courtesy of : The Journal of the Institution of Engineers Malaysia)

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REMEDIATION OF CONTAMINATED LAND WITH SOLIDIFICATION / STABILISATION TECHNOLOGY

By

Ahsan Iqbal Bela*

STABILISATION/SOLIDIFICATION (S/S) IS A REMEDIATION TECHNOLOGY THAT RELIES ON THE REACTION BETWEEN A REAGENT AND SOIL TO REDUCE THE MOBILITY OF CONTAMINANTS. IMMOBILISATION IS ACHIEVED BY REACTION OF CONTAMINANTS WITH REAGENTS TO PROMOTE SORPTION, PRECIPITATION OR INCORPORATION INTO CRYSTAL LATTICES AND/OR BY PHYSICALLY ENCAPSULATING THE CONTAMINANTS. ***AHSAN BELA****, ENGINEER, MAY GURNEY LTD, LOOKS AT THE USE OF THE TECHNIQUE ON TWO KEY PROJECTS*

GENESIS IN RADIOACTIVE WASTE

The genesis of most modern-day Stabilisation/Solidification (S/S) systems comes from the radioactive waste (rad-waste) solidification field trials undertaken in the US that began in the 1950s. Early on, the nuclear industry recognised the need for solidification of rad-waste in drums and other containers before these could be shipped or buried at government-controlled disposal sites. For decades, mines in Canada and the United States have been using Portland Cement alone, with fly ash, or in combination with solid mine waste to produce cemented hydraulic backfill, which helped eliminate the need for structural pillars or walls within the body of the mine. More recently, the Environmental Protection Agency (EPA) has defined stabilisation and solidification as follows:

Stabilisation refers to those techniques that reduce the hazard potential of a waste by converting the contaminants into their least soluble, mobile or toxic form. The physical nature and handling characteristics of the waste are not necessarily changed by Stabilisation. Solidification refers to techniques that encapsulate the waste in a monolithic solid of high structural integrity. The encapsulation may be fine waste particles (micro encapsulation) or have a large block or container of waste. *Solidification* does not necessarily involve a chemical interaction between the wastes and the solidification reagents, but may mechanically bind the waste into the monolith. Contaminant migration is restricted by vastly decreasing the surface area exposed to leaching and/or by isolating the waste within an impervious capsule.

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THREE PRIMARY GROUPS OF POLLUTANTS

The mechanism of fixation or stabilisation is different for three primary groups of pollutants; metals, other inorganics and organics. Metals are the only really hazardous constituents that cannot be destroyed or altered by chemical or thermal methods and so must be converted into the most insoluble form possible to prevent their re-entry into the environment.

S/S is not the only technique to treat organic contamination. Hazardous organic wastes lend themselves primarily to destructive treatment by processes such as incineration, biodegradation, thermal desorption, chemical oxidation and de-chlorination. However, many industrial wastes and contaminated materials contain a small amount of toxic organic compounds at levels that make organic destruction process not only very expensive, but also sometimes ineffective. For these reasons, it is important to have developed "fixation" techniques for low-level organic contaminants. S/S soil-treatment techniques have shown some success in treating oil and solvent-based organic waste.

Other inorganic contaminant species mainly include Cyanide, Fluoride, Chloride, Ammonia, Sulphide and Nitrate. These are commonly treated with special chemical-treatment processes, such as converting Fluoride into the form of calcium fluoride (CaF), which is highly insoluble.

EX-SITU OR INSITU?

S/S soil treatment can be carried out as insitu or exsitu processes. A range of both methods of application have been developed to address potential practical constraints and characteristics, including:

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*(BEng (Hons) MSc DIC)

Ex-situ methods

- Excavation and mixing with reagent in plant designed for that purpose (e.g. pug mill);
- Direct mixing of soil with reagent in thin layers, e.g. by rotovation, followed by compaction;
- In-drum processing;

In-situ methods

- Using soil-mixing equipment (eg: modified hollow stem auger) to inject and mix the reagents as they pass through the contaminant-bearing soils.

EX-SITU - NEWLYN HARBOUR, CORNWALL

A recent example where the ex-situ S/S method was used on a soil-remediation project is at Newlyn, Cornwall. Newlyn Pier and Harbour Commissioners had gained funding and development rights to build a new pontoon system at Newlyn Harbour to support the small fishing fleet. May Gurney was appointed as the main contractor on site. To build the new pontoon part of the existing seabed was to be dredged but the dredged silt materials were mainly contaminated with organic tin compounds. It is most likely that these contaminants had been deposited primarily through the repeated scraping and repainting of boat hulls with anti-fouling paint. This was traditionally undertaken at low tides when the boats were lying on the exposed harbour bed. Since the implementation of the new Landfill Directive the disposal cost of contaminated soil has increased significantly. There are less than 10 landfill sites in the UK which can accept contaminated soil as hazardous waste, none of these being in the South West region of UK. Therefore adopting a dig-and-dump solution for the contaminated silts at the Newlyn Harbour site would have meant adding approximately £2M to the project budget. All the options were examined to find the most cost effective solution and ex-situ S/S was identified as best solution. In fact this reduced the cost of treating the dredged contaminated silts down to approximately £200,000. Without this reduction in cost the project would not have been able to go ahead as the client was working within a capped budget. The laboratory based Treatability Study and Site Specific Working Plan were prepared which demonstrated the effectiveness of the technique. Newlyn Pier & Harbour Commissioners and the Environment Agency UK accepted the proposals, allowing the work to start mid February 2006. Approximately 7.300 m^3 of contaminated silt was stabilised during February and March 2006. The treatment grout was prepared in a static concrete drum on site and specified amounts were pumped into a mixing skip. There the contaminated silts and treatment grout were mixed using a homogenizing bucket fixed to a modified excavator. Testing of treated material shows that the leachability of contaminants suite reduced up to 90 per cent 28 days after the contaminated soil and treatment slurry had been mixed. Newlyn Pier & Harbour Commissioners received an exemption from EA to use the treated material as back fill for a car-park area on the basis of low-leaching criteria.

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Newlyn Harbour

INSITU : SIR JOHN ROGERSON QUAY

A good example of a successful in-situ S/S soil treatment is the Sir John Rogerson Quay's redevelopment project in the former industrial dockland area of Dublin, where a low-permeability cut-off wall and soil treatment with simultaneous ground-improvement works were carried out by May Gurney. The site covers approximately 1.1ha and is located to the south of the Quay on the reclaimed floodplains of the river Liffey. It had been used over many years for a number of industrial and polluting activities, including shipbuilding, rope-making, a coal and timber yard, a paint factory, shipping ice/cold storage, motor-vehicle storage and lorry maintenance. Elevated levels of benzene. Phenol. Naphthalene and benzo(a)pyrene were identified in the upper fill material, natural gravel soils, and perched groundwater across the site. The process works via the use of modified drilling auger tools designed to mix rather than replace soil, together with conventional piling plant. A treatment grout. Which contained cementitious materials was mixed in-situ with contaminated soils to produce a homogenous treatment column in the ground. These columns were overlapped in various configurations to meet different remediation objectives whilst also enhancing certain properties of the in-situ soils and bearing capacity over the treated zone. The augers were initially rotated into the ground to the treatment depth then on withdrawal under reverse rotation the treatment slurry was pumped down the hollow stem of the auger and mixed with the soil column in-situ to form a soil-mixed column.



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Sir John Rogers Quay

LAHORE WATER SUPPLY SYSTEM AND MONITORING OF DRINKING WATER

By

Zainab Abbas Soharwardi and Dr Javed Iqbal

Abstract

WASA Lahore is supplying drinking water to citizen of Lahore in its service area of 350 sq kms and it serves 88% of population of Lahore. WASA Lahore is supplying potable drinking water to the citizens of Lahore. Water quality is monitored at the source distribution system including on regular basis. Water quality of drinking water at source is good as it contains basic minerals like sodium, magnesium, calcium, potassium etc, which are necessary for life and are present in permissible limits according to WHO guide line values. To show quality of drinking water of Lahore, analysis values of 25 tube wells and annual report of water sampling are included in this paper. All parameters are within limits according to WHO guide lines. This study also tells us about shrinkage of ground water level. WASA supply drinking water to citizens of Lahore by pipeline distribution system. As pipeline system is a large system and there are chances of contamination of drinking water, in this paper it is discussed, how WASA is controlling contamination, in distribution system and communicates water lists users and public. Activities and steps taken by WASA to improve quality of drinking water are also discussed in this paper.

Introduction

Lahore is the second largest city in Pakistan with a population of more than 7 million. Whereas 87% population has access to safe water supply, increase in water supply and efficiency improvements through water conservation and water loss reduction are required to meet the demands of the rapidly increasing population.

WASA Lahore service area

WASA's jurisdiction comprises of following six towns in terms of water supply;

- Ravi Town
- Shalimar Town
- Data Gunj Buksh Town
- Aziz Bhatti Town
- Iqbal Town
- Nishter Town.

These towns are divided into 25 zones, which are called sub-divisions. 6.783 million of population lives within the jurisdiction of WASA, which has provided 564,000 water supply connections. 5.466 millions are served, which is 81% of the total population in WASA area. Rest of19% population have either no WASA supply connection such as private developers or have their own arrangements or illegal connections. In these six towns, Aziz Bhatti Town is smallest of all the aforementioned towns. Ravi Town, Shalimar Town and Gunj Buksh Town have similar population. Lahore city is particularly expanding to south, where Iqbal Town is located which has been developed recently. Total population and served population by WASA Lahore is given below in fig 1 and table 1.

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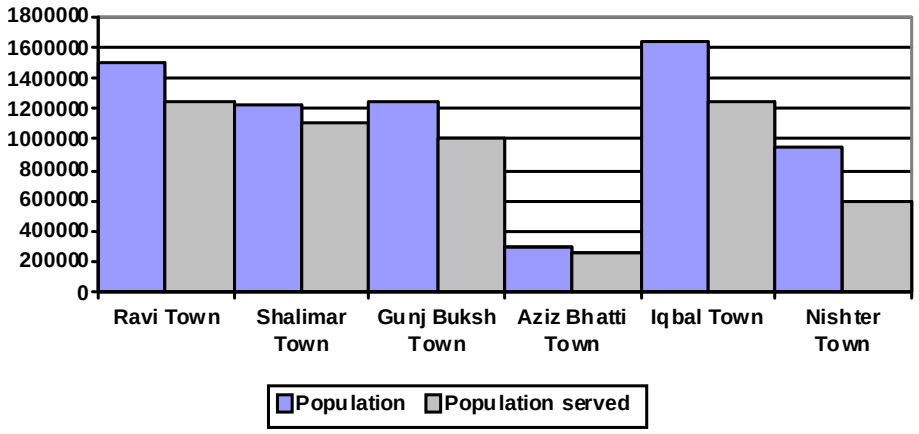


Fig 1: Graph b/w area and population

Table 1: Total population and % age of served population

Sr. No.	Description of Area	Population	No. of WASA Connections	Population Served	% of Population Served
1	**RAVI TOWN**				
1.1	City	280000	24784	235106	**84%**
1.2	Shahdrah	220000	12111	102943	**47%**
1.3	Farakhabad	215000	17884	147543	**69%**
1.4	Data Nagar	288500	20607	275400	**95%**
1.5	Misri Shah	259670	27805	255600	**98%**
1.6	Shadbagh	230220	22488	226300	**98%**
	Sub Total	1493390	125679	1242892	**83%**
2	**SHALIMAR TOWN**				
2.1	Mughalpura	683420	42520	615078	**90%**
2.2	Baghbanpura	537239	38417	483516	**90%**
	Sub Total	1220659	80937	1098594	**90%**
3	**GUNJ BUKSH TOWN**				
3.1	Krishan Nagar	406825	31068	378349	**93%**
3.2	Ravi Road	304888	24998	213421	**70%**
3.3	Mozang	121707	15135	59636	**49%**
3.4	Anarkali	150700	13205	132616	**88%**
3.5	Gulberg	133560	18549	133560	**100%**
3.6	Shimla Hill	113873	9975	80849	**71%**
	Sub Total	1231553	112930	998431	**81%**
4	**AZIZ BHATTI TOWN**				
4.1	Mustafa Abad	99200	6857	91264	**92%**
4.2	Taj Pura	174000	22500	165300	**95%**
	Sub Total	273200	29357	256564	**94%**
5	**IQBAL TOWN**				
5.1	Iqbal Town	311576	28705	180000	**58%**
5.2	Samanabad	424763	43177	320000	**75%**
5.3	Sabzazar	150000	10349	98094	**65%**
5.4	Ichra	389000	31568	389000	**100%**
5.5	Johar Town	360000	20564	265000	**74%**
	Sub Total	1636339	134363	1252094	**77%**

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6	**NISHTAR TOWN**				
6.1	Industrial Area	315500	27500	166400	**53%**
6.2	Green Town	200918	18160	138000	**69%**
6.3	Garden Town	211000	15989	165500	**78%**
6.4	Town Ship	200366	19359	148000	**74%**
	Sub Total	927784	81008	617900	**67%**
	Total	**6782925**	**564274**	**5466475**	**81%**

Monitoring rules and sampling frequency recommended by WHO guidelines
For untreated water entering the distribution system, the following maximum intervals between successive routine examinations are proposed by WHO guideline:

Population served	**Maximum interval between successive samplings**
Up to 20 000	**One month**
20 001 - 50 000	**Two weeks**
50 001 - 100 000	**Four days**
More than 100 000	**One day**

On each occasion, samples are taken from all the points at which the water enters the distribution system. For WASA system, source is underground water.

With regard to samples to be collected from the distribution system, whether the water has been subjected to treatment or not, the following maximum intervals between successive samplings and minimum numbers of samples to be examined in each month are proposed:

Population Served	**Maximum interval between successive samplings**	**Maximum number of samples to be taken from entire distribution system**
Up to 20 000	One month	
20 001-50 000	Two weeks	**One sample per 5000 of population per month**
50 001-100 000	Four Days	
More than 100 000	**One day**	**One sample per 10 000 of population per month**

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It is considered justifiable to reduce the minimum number of samples to one sample per 10,000 of the population per month when the population exceeds 1,00,000, since in systems serving population of that size, some samples would be examined each day. To meet sampling frequency recommended by WHO, WASA laboratory collects water samples daily from Lahore. The samples are not necessarily to be taken from the same points on each occasion, as recommended by WHO guidelines.

Activities of WASA Lahore to provide safe drinking water Two steps are involved in providing safe drinking water to citizens

1. Chlorination
2. Awareness to public

- Through chlorination, we disinfect our distribution pipeline systems so that our public gets safe drinking water. To ensure chlorination WASA laboratory collects drinking water samples from sources and distribution systems as well.

- During sampling, WASA laboratory teams visit WASA consumer's houses and provide awareness to clean their water tanks and advise them or instruct them to collect water for drinking directly from taps of water supply instead of their water tanks. During monsoon season when there are many chances of outbreak of epidemics, WASA sampling teams educate public about methods of getting safe drinking water and encourage them to boil drinking water till first boil.

Challenges WASA have to Face

Draw down of ground water of Lahore is a sensitive issue as due to shrinkage of underground water level, we have to face two types of problems :

1. Shortage of drinking water.

2. Contamination of underground water.

Table 2: Annual draw down of underground water of Lahore

Sr. No.	Name of Sub Division	Static Water Level (SWL)				Difference			
		FEB./05 (*m)	FEB./06 (m)	FEB./07 (m)	FEB./08 (m)	05/06 (m)	06/07 (m)	07/08 (m)	05/08 (m)
1	Shahdara	10.97	12.14	11.93	13.12	-1.17	0.21	-1.19	-2.15
2	City	25.15	26.07	26.99	27.34	-0.92	-0.92	-0.35	-2.19
3	Data Nagar	20.16	21.77	23.12	25.33	-1.61	-1.35	-2.21	-5.17
4	Misri Shah	25.70	26.33	27.69	28.42	-0.73	-1.26	-0.73	-2.72
5	Baghban pura	25.45	26.94	27.75	29.03	-1.49	-0.81	-1.28	-3.58
6	Mughalpura	28.45	30.41	31.33	32.01	-1.96	-0.92	-0.68	-3.56
7	Mustafaabad	32.67	33.63	33.95	35.43	-0.96	-0.32	-1.48	-2.76
8	Taj Pura	28.95	29.14	28.33	31.94	-0.19	0.61	-3.41	-2.99
9	Ravi Road	23.65	23.68	23.55	23.35	-0.03	0.13	0.20	0.30
10	Islam Pura	23.94	24.59	23.84	23.72	-0.65	0.75	0.12	0.22
11	Shimla Hill	30.72	32.06	33.12	33.87	-1.34	-1.06	-0.75	-3.15
12	Mozang	33.04	36.33	35.72	36.61	-2.29	-0.39	-0.89	-3.57
13	Gulberg	32.85	34.29	35.11	36.65	-1.44	-0.82	-1.54	-3.80
14	Samanabad	24.95	26.27	27.27	27.25	-1.32	-1.00	0.02	-3.30
15	Allama Iqbal Town	25.24	24.89	25.14	25.33	0.35	-0.25	-0.19	-0.09
16	Ichra	32.82	34.33	35.02	35.02	-1.51	-0.69	0.00	-2.20
17	LA. Johar Town	24.08	25.20	25.65	25.80	-1.12	-0.45	-0.15	-1.72
18	Garden Town	30.09	31.49	33.10	34.18	-1.40	-1.61	-1.08	-4.09
19	Industrial Area	25.95	27.59	39.55	30.21	-1.64	-1.96	-0.66	-4.26
20	Town Ship	29.77	31.58	33.11	34.96	-1.81	-1.53	-1.85	-5.19
21	Green Town	22.01	23.36	24.61	26.45	-1.35	-1.25	-1.84	-4.44
22	M.E.S. Tubewells	26.25	26.59	27.67	27.67	-0.34	-1.08	0.00	-1.42
				Average		-1.13	-0.73	-0.91	-2.77
				Interval (yr)		1.00	1.00	1.00	1.00

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*m= metre

Quality of drinking water in 2009

WASA laboratory follows WHO guidelines and PSQCA standards to monitor and control drinking water quality. WASA Lab. is responsible to monitor quality of drinking water. Sampling is done under three types of sampling programmes.

- Routine sampling
- Complaint sampling
- Follow up sampling

Result reports are arranged in form of monthly reports and annual reports. In 2009, 4344 water samples were collected from different areas of Lahore falling under jurisdiction of WASA-LDA. These samples were analyzed in WASA Laboratory to know about quality of drinking water. About 82% samples were found safe and 18% samples were contaminated and unfit for human consumption. Sampling was done from locations where water samples were found unfit under follow-up sampling programme. In 2009, 41% water samples were collected under routine sampling, 41% samples were collected upon complaints received about quality of drinking water from different sources and samples were collected under complaint sampling programme. 18% samples were collected under follow up sampling.

Two types of contamination were observed.

1. Physical appearance of water samples.

2. Bacterial contamination

Among 18% unsafe samples, 2% samples were unfit on the basis of physical tests (presence of rust, color and odor) and 16% on bacterial tests (E.coli). For present study 25% water samples were collected from sources and analysed for sixteen parameters. Locations and results are given in table 3 and table 4 respectively.

Samples are collected in sterilized bottles for bacterial test and in glass bottles for chemical tests. Membrane filtration method was used for E coliform test. pH. Turbidity, conductivity and total dissolved solids were analysed by calibrated meters immediately after collection of samples. Total hardness, Ca, Mg, alkalinity, bicarbonates, chlorides and sulphate was determined by titration methods. Sodium and potassium was determined by flame photometer. Iron was determined by kit method. NV 202 spectrophotometer was used for nitrite detection.

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Results and Discussion

Table 3: Sampling locations

Locations (Code)	Locations (Code)	Locations(Code)	Locations(Code)	Locations(Code)
Shadbagh (X 1)	Ravi Ground (X6)	G block Sabzazar (X11)	Khokhar Road 2 (X16)	Munshi Hospital (X21)
Timber Market No.52 (X2)	Nasir Bagh (X7)	A block Sabzazar (X12)	Khokhar Road 4 (X17)	Match Factory (X22)
Chandan Chowk Township (X3)	Abu Baker Block Garden Town (X8)	Pir ghazi road (X13)	Hanif Park (X18)	GT Road Shahdara (X23)
Yohauna Abad Block-B (X4)	Upper Mall (X9)	Karmabad (14)	Hussain Park (X19)	Shahdara Town (X24)
Main Bazar Ghari Shahu (X5)	Sanda Road (10)	Misri Shah (X15)	Paracha Colony (X20)	Farid Kot House (X25)

From Table 4 it can be seen that pH, turbidity, conductivity values are within guideline values. Total hardness values falls between 94 to 550ppm close to bottled water standards. Calcium and magnesium both are present in suitable quantity in drinking water samples. Total alkalinity values falls between 98 to 300ppm a bit higher at three sources. Chlorides are also present in permissible limits. Nitrites are nil in all samples. Iron sulphate and bicarbonates are also in permissible range.

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Table 4: Physiochemical results of 25 water samples collected from sources

Name of T/W	*p.H.*	*Tur.*	*TDS*	*Con.*	*TH*	*Ca*	*Mg*	*Alk*	*Cl*	*NO_2*	*CO_3*	*HCO_3*	*Na*	*K*	*NH_3*	*Fe*	*SO_4*	*E.coli*
X1	8.1	2.67	243	386	160	32	19.2	180	15	Nil	Nil	180	18	0.02	Nil	0.02	8.5	Nil
X2	8.0	0.95	300.5	477	94	16.8	12.48	146	16	Nil	Nil	146	12	0.1	Nil	0.02	5.9	Nil
X3	8.0	7.18	630	1000	184	34.4	23.52	200	67	Nil	Nil	200	21	0.6	Nil	0.02	8.9	Nil
X4	8.1	1.24	732	1162	186	36.2	23.5	300	31	Nil	Nil	364	32	0.5	Nil	0.02	6.34	Nil
X5	8.2	1.16	473	771	312	52	43	300	59	Nil	Nil	356	14	0.1	Nil	0.02	12.9	Nil
X6	8.1	1.09	199.7	317	140	36	12	118	7	Nil	Nil	118	8	0.3	Nil	0.02	8.9	Nil
X7	7.3	2.24	582.1	924	540	104	67.2	300	140	Nil	Nil	334	50	3	Nil	0.02	11.2	Nil
X8	7.9	0.73	560	889	164	33	20	250	15	Nil	Nil	250	9	0.5	Nil	0.02	9.2	Nil
X9	8.0	0.64	267.1	424	104	18	14.4	186	22	Nil	Nil	186	11	0.7	Nil	0.02	9	Nil
X10	8.0	0.7	216.7	344	118	25.6	12.96	148	9	Nil	Nil	148	6	0.2	Nil	0.02	7.9	Nil
X11	8.2	1.41	563.1	851	250	44	33	214	55	Nil	Nil	214	17	0.7	Nil	0.02	10.3	Nil
X12	8.2	1.33	194	308	214	57	16	184	46	Nil	Nil	184	14	0.4	Nil	0.02	8.5	Nil
X13	8.0	0.18	469.3	745	308	59.2	38.4	228	87	Nil	Nil	228	18	0.4	Nil	0.02	7.7	Nil
X14	8.0	1.13	232.4	369	102	24.8	9.6	148	21	Nil	Nil	148	2	0.1	Nil	0.02	5.9	Nil
X15	8.3	0.51	217.3	345	184	49.6	14.4	136	23	Nil	Nil	136	1	0.2	Nil	0.02	7.4	Nil
X16	7.9	0.73	276.5	439	192	46	18	156	10	Nil	Nil	156	5	0.2	Nil	0.02	7.6	Nil
X17	8.0	1.12	274	435	184	45	19	160	13	Nil	Nil	160	5	0.2	Nil	0.02	6.6	Nil
X18	8.4	2.25	169	268	102	23.2	10.5	98	12	Nil	Nil	98	4	0.2	Nil	0.02	5.6	Nil
X19	8.0	0.37	244.4	388	172	47	13	172	10	Nil	Nil	172	5	0.2	Nil	0.02	Nil	Nil
X20	7.9	6.9	586	930	198	30	15	180	25	Nil	Nil	180	17	0.2	Nil	0.02	7.5	Nil
X21	8.0	0	175.7	279	124	26.4	13.92	110	7	Nil	Nil	110	5	0.2	Nil	0.05	7.1	Nil
X22	8.1	0.77	342.7	544	204	46.4	21.1	206	11	Nil	Nil	206	8	0.3	Nil	0.02	11.2	Nil
X23	8.5	0.47	288	457	172	48	12.4	146	20	Nil	Nil	146	5	0.8	Nil	0.02	9.8	Nil
X24	8.3	1.19	225.8	358	152	35	15	136	9	Nil	Nil	136	25	0.5	Nil	0.02	8.5	Nil
X25	7.8	3.42	867	1375	550	110.4	65.7	270	155	Nil	Nil	270	21	0.02	Nil	0.02	12.5	Nil
WHO Values	7.0-9.2	5NTU	100-1000	-	500	-	-	500	250	-	-	-	-	-	NIL	0.3	200	0/250ml

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Results of basic parameters of drinking water show that quality of drinking water of Lahore is good. All sources show negative results for E.coli test. E.coli test is a shortcut to know about bacterial contamination in drinking water as at sources due to deep down depth of tube wells, there is no chances of mixing of sewerage water or waste water so this test is negative but in distribution system it may or may not be positive as in distribution system due to pipelines there are many chances of such type of contamination and to remove this type of contamination chlorination at source is done.

As compared to other cities like Kasur, Muzafargarh, water quality of Lahore is good as it is a blessing of God but people are wasting this blessing in different activities i.e. washing of cars, leakage of water taps etc

Steps taken by WASA Lahore to solve problem related to drinking water

WASA Lahore has a laboratory to monitor quality of drinking water at source as well as from taps of distribution system to ensure that citizens of Lahore under WASA jurisdiction are taking safe drinking water. Staff of WASA lab. is experienced and dedicated to ensure supply of pure, clean and hygienic water to the citizens of Lahore. To monitor the quality of drinking water following steps are involved :

Step 1:
About 30 to 35 water samples are collected from different areas of Lahore in a day.

Step 2:
All samples are analyzed in WASA lab for physiochemical tests and bacterial tests

Step 3:
If any abnormality in physical tests (odor, color or turbidity) is found then concerned operation staff is immediately contacted on telephone to remove contamination.

Step 4:
Chemical tests are performed next day of collection and in the same day report of E.coli tests is also received from bacteriological section of WASA lab. Presence of E. coli is an indication of sewerage mixing in distribution system.

Step 5:
Results are arranged and reports are sent to all concerned sections.

Steps 6:
Areas where samples are found unfit on the basis of chemical or bacterial results sampling is done under follow-up programme.

Complaints about quality of drinking water is received by WASA complaint cells and immediately message is conveyed to WASA lab to take samples.

WASA Lahore is also working to search alternate sources for drinking water to reduce pressure on underground water and how we can give maximum recharge to our underground water. For proper communication (National and International) WASA Lahore is planned to give data about quality of drinking water to web and publishing of analysis reports, papers etc.

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Conclusions and Recommendations

- Discourage wasting of water
- Recycling of water for industrial applications
- Search for alternate sources of drinking water
- Regular monitoring of drinking water
- Awareness to public about quality and quantity of drinking water

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