Hydraulic Design of Leisure Facilities

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Purpose

- The purposes of hydraulic design as applied to Aquatic Facilities include:
  - Provision of a mechanism for collection of pool water, its conveyance to a water treatment system, and return to the pool.
  - Systems and equipment for removal of physical contaminants from the water (skimming, filtration).
  - Systems and equipment for neutralizing, and in some cases removal of, living organisms, especially pathogens, and organic wastes in the water. – (Sanitation)
  - Maintenance of desirable temperature conditions (Heating or Chilling).
  - Provision for mixing the conditioned water in the pool to ensure effectiveness of these processes across the full extent of the pool.

Let's look at these in closer detail.

COLLECTION OF POOL WATER

- The importance of surface skimming is well understood.
- In outdoor pools, wind direction should be considered in placing skimming elements.
- Suction outlets need careful consideration, using rated or “unblockable” fittings. (AS 1926.3-2010 Swimming pool safety - Water recirculation systems). Not well known is the fact that there is scope for individual design of these in the standard.
- Design of wet deck systems should result in near-silent operation.
- Wet deck systems should be adequate to convey the flow rate without overtopping, and should include some reserve capacity for splash.

- APPROPRIATE DESIGN
- Provision of spare capacity in wet deck channels to allow for potential settlements, wind actions and user activity resulting in significant overloading of side of the pool.
- Detailing of outlets to ensure silent operation, together with efficiency of flow.

- EXAMPLES
- Sloped channel walls – pool side
- Rounded pipe entries
- Deepening at channel outlets.

ELEMENTS OF FILTRATION DESIGN

FILTRATION

- Commonly adopted filtrations include
- Sand (or glass) Media
- Pre-coat Media or UFF
- Cartridge

- APPROPRIATE DESIGN
- We believe the most significant factor in filtration design is adopting filter bed loadings appropriate the medium involved. We strive for bed loadings not greater than 30m/hr in sand filters, 3 m/hr in media filters, and 1.5-1.8 m/hr in cartridge filters.
- Benefits include longer filter runs, less waste, and better filtered quality.
- Don’t believe and certainly do not adopt manufacturer’s figures regarding filter capacity, especially in the ‘domestic’ filters ranges.
- One of the key design figures for sand filters is backwash flow rate.

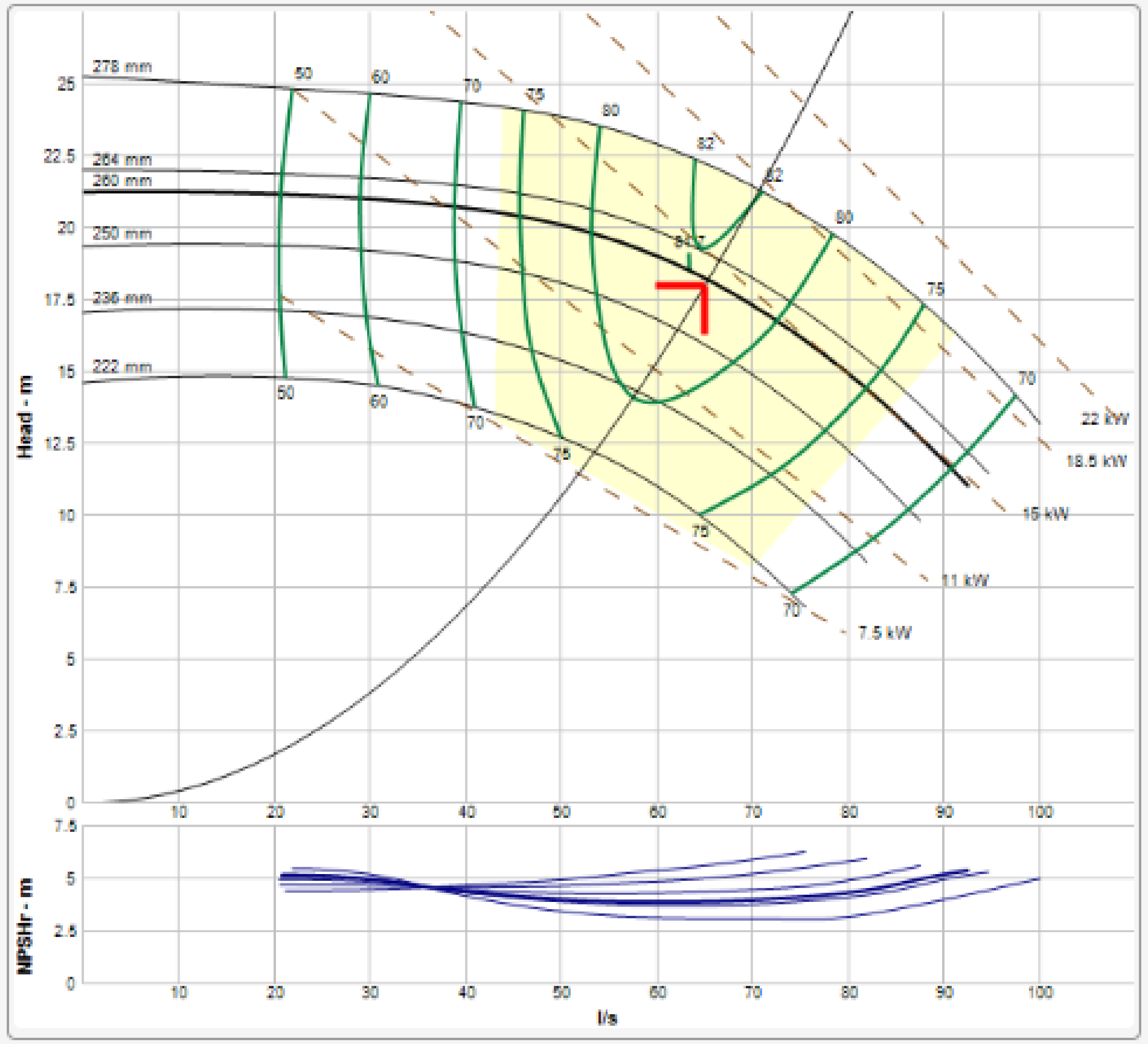
- EXAMPLES
- We see many examples of poorly design filtration circuits where backwash flows are just unachievable. Hence, an hour after performing a backwash the filter indicates a need for backwashing again.

PUMPING

- Pumps are poorly understood by most people, and in many cases marketing is deceptive.

- APPROPRIATE DESIGN
- Design requires more than reference to a product brochure.
- Variables involved in a well-considered pump selection include
  - Impeller Sizing
  - BEP (Best Efficiency Point)
  - NPSHR (Net positive Suction Head Required, and it’s arch-enemy, cavitation)
  - Ability to vary pump speed with varying stages of filter cycle, but most essentially to reduce pumping costs when bather load is not present (after hours)

- EXAMPLE
- (See over)



Catalog

Request For Quote

Pump

Type	ISOspec CM Series
Size	150x125-250
Curve	4 Pole Motor
Impeller	---
Speed	1450 rpm
	Fit to Design
Diameter	260 mm
	Fit to Design

Data Point

Flow	65.3 l/s
Head	18.2 m
NPSHr	3.92 m
Efficiency	81.3 %
Power	14.2 kW

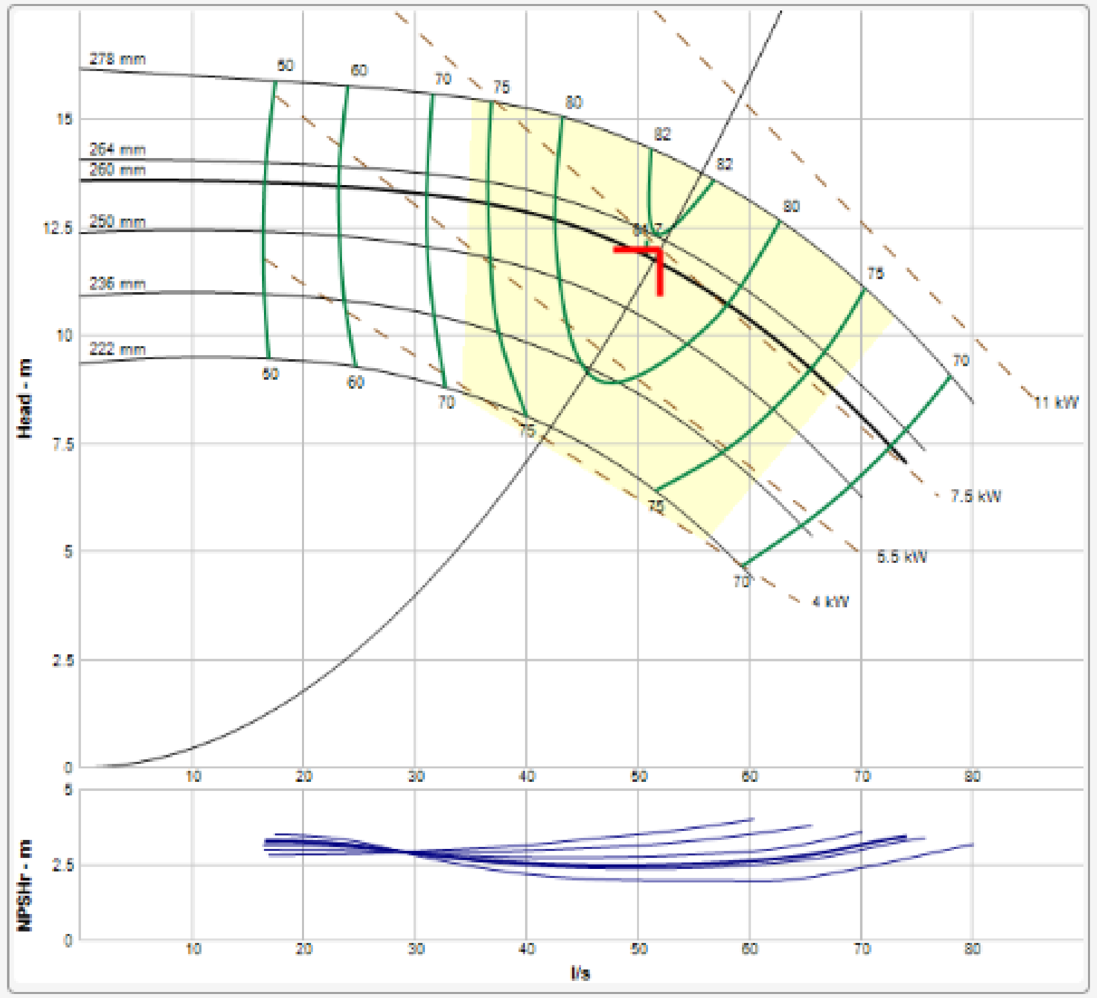
Motor

Standard	IEC
Enclosure	TEFC
Frame	160L
Size	15 kW

Motor Selection

Graph Settings

- Manufacturer Settings
- Custom



Catalog

Request For Quote

Pump

Type	ISOspec CM Series
Size	150x125-250
Curve	4 Pole Motor
Impeller	---
Speed	1160 rpm
	Fit to Design
Diameter	260 mm
	Fit to Design

Show Warnings

Data Point

Flow	51.4 l/s
Head	11.7 m
NPSHr	2.5 m
Efficiency	81.5 %
Power	7.25 kW

Motor

Standard	IEC
Enclosure	TEFC
Frame	160L
Size	15 kW

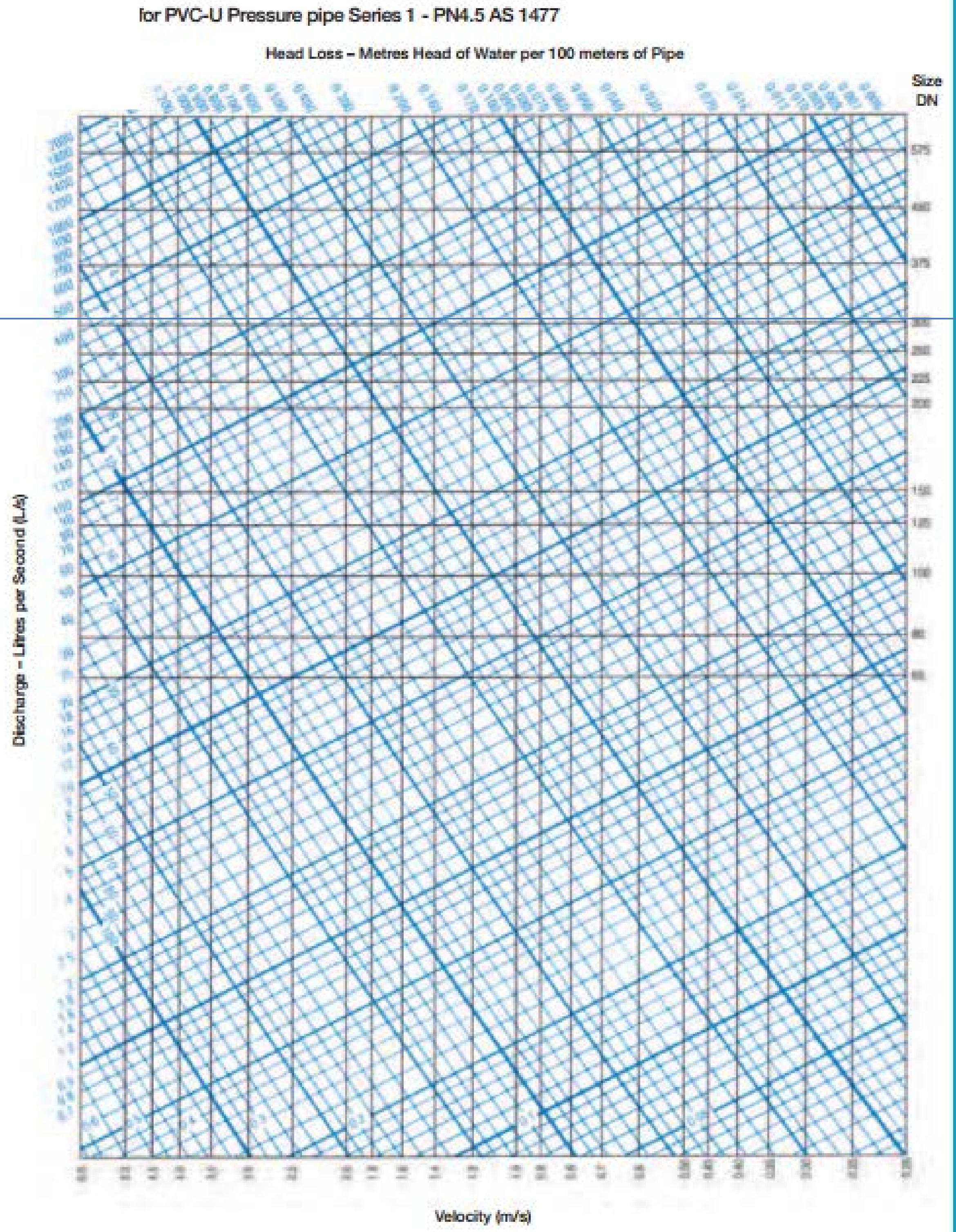
Motor Selection

Graph Settings

- Manufacturer Settings
- Custom

PIPEWORK

- Pipework design is a more complex exercise than most people realize, especially in branched networks.
- Inappropriate design can lead to high pumping costs, poor filter backwash performance, inadequate filtration and turnover performance and poor circulation patterns in pools.
- The following reference chart is often the extent of the expertise of some “consultants” in the industry. It allows the estimation of friction loss in a length of pipe for a given flow rate



PIPEWORK (Cont)

- In reality, hydraulic circuits rarely involve a single straight run of pipe. A more realistic analysis of a simple pump intake circuit might be as follows. It includes the intake, some 90 degree elbows and a Hair & Lint strainer as well as 30m of intake pipe. One would expect such a long length of pipe to be the dominant loss, but the loss from fittings is significantly greater. The software is our in-house development, so it is not available. (See next page for the data)

- We see many hydraulic designs where the proposed pipework (or more significantly the existing pipework) has been developed without any design knowledge.

PIPEWORK (Cont)

Project Data	Proserpine Water Play
Company	
Location	
Project	
Area under investigation	
Author	
Checker	GJW
Date	24-04-18
Job No.	

Pipe 1 Data		
Pipe Material (pull down)	PVC PN9	
Pipe Diameter (mm, pull down)	250	NOTE PIE DIA REQUIRED TO LIMIT NPSH
Pipe Length (m)	30	
Water Level (m)		
Reference Height (m)	1.2	Static Lift

Situation Data	
Water Flow Rate (lps)	65
Required output Pressure (psi)	
Required output velocity (m/s)	

Note: To change coefficients or customise fittings, click on the 'fitting coefficients' tab.

Fittings	**no.**	**K**	**ΣK**
Slightly Rounded Inlet	1	0.25	0.25
Sudden Enlargements	1	1	1
90 Degree Elbow	4	1.2	4.8
H&L Strainer	1	7	7
	0		
	0		
	0		
Totals	7		13.05

Chosen Pipe	Vinidex PVC PN9
Max Pressure (psig)	150
Roughness (mm)	0.003

Intermediate Calcs	
Roughness (m)	0.000003
ID	259.4
Cross Sectional Area (m^2)	0.053
Water Velocity (m/s)	1.23
Water Specific Gravity	0.9977
Viscosity (Ps)	1.01E-06
Reynolds Number	315887
Friction Factor	0.013767877
Friction Slope	0.004092277
Friction Loss (m)	0.122768325
Adjusted Loss	0.129280096
M Head from fittings	1.01

Result Checking	
1/√λ	8.522490135
-2log(k/3.7D + 2.51/(Re√λ)	8.299389009
Accuracy of solution	2.62%

		PSI	KPA
Total Head from friction =	1.14	1.61	11.14
Total Head from Height=	1.2	1.70	11.77
Residual head (pressure)	0	0.00	0.00
Residual head (velocity)	0	0.00	0.00
Total Head	2.34	3.32	22.96

SANITATION

- In any public health jurisdiction sanitation involves provision of a residual concentration of an approved sanitizing agent in the pool.
- Predominant primary sanitizing agents are chlorine and bromine, with lesser used and not automatically meeting with approval are derivatives of these , Hydrogen Peroxide.
- Some ions have a partnering role with these but the residual component is till required, as it provides the only reliable means of monitoring the sanitizing residual in the pool.
- I wont go into some other products on offer, such as electromagnetic strapons with 20-30W power supplies attached.
- Alternatives involving Ozone and UV are not widely used in our designs.
- We have achieved very satisfactory design procedures using Salt and Low-salt chlorination systems, and have several 50m pools under this system. Salt chlorination is almost mandatory for performance in indoor pools where Sodium Hypochlorite causes TDS to become a problem.

- APPROPRIATE DESIGN
- Design of sanitizing systems must include adequate means of supplying chemicals at a rate determined by instantaneous demand.
- Storage of chemicals is a constant concern and salt-based sanitation systems overcome both aspects of storage and handling which can be hazardous.

- EXAMPLES
- Recent Examples of Salt or Low-salt electro-chlorination installations include, along with every hotel or resort pool we have documented in the last 30 years, (see over)

SANITATION (Cont)

- EXAMPLES

- QUT Gardens Point 50m indoor Pool
- Marist Ashgrove 50m Outdoor Pool
- Sunshine Coast Grammar School 50m outdoor pool and 25m learn-to-swim indoor pool.
- Mt St Michael's college Ashgrove 25m outdoor Pool

- **ADD-ONS**

- I think our total score for pool sanitation systems utilizing add-ons, after more than 30 years in the business, now stands at
- Ozone 1
- UV 3

HEATING (& Chilling)

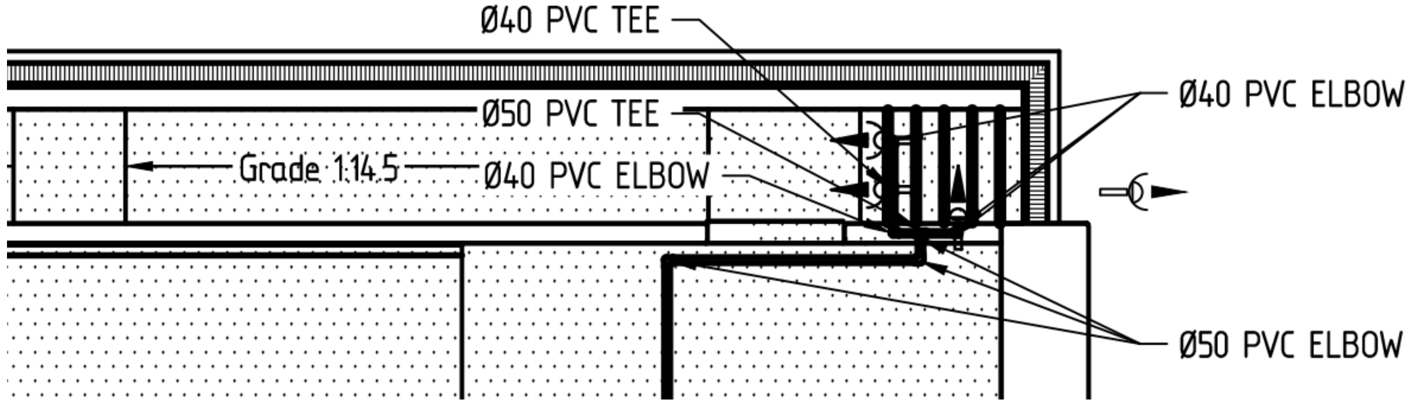
- Heating is usually a necessity associated with climate (cold climates, extended or year-round swim seasons)or lack of access to sunlight (Indoor Pools).
- Heating is usually provided by one of
  - Mechanical Heat Pumps
  - Gas Heaters circulating pool water
  - Heat Exchangers utilizing an available heat source such as geothermal, gas boilers on hot water systems, or waste heat from co-generation and tri-generation systems.

- Chilling is available at little additional cost with some heat Pumps.

- APPROPRIATE DESIGN
- Design needs to take into account
  - Target temperature
  - Environmental conditions
  - Installation details of the equipment especially in relation to exhaust for gas heaters and air flow for heat pumps.
  - Operating hours, tariff structures
- Some installations require over-riding control to limit peak demand by turning off heat pumps (or other equipment) as this figure is more becoming more commonly factored into the energy supply rate to a facility.
- An anomaly of the industries supplying the relevant energy sources is that it is still attractive to install gas heating in Victoria.

CIRCULATION (Mixing within the pool)

- There is little to be gained if the water once treated isnt well circulated on its return to the pool.
- Operator's will be aware of various instances of algae growth in the 'dead' corner of a pool, or hot spots in an outdoor pool, on a beach entry to a splash pad, or similar examples of failure in design.
- One of the key elements a designer has to work with is the direction and velocity at the inlet locations of the water being delivered to the pool.
- Isaac Newton made some observations about bodies in motion remaining in motion, and this energy can be implemented to direct flow to potential problem areas in pools
- EXAMPLES
- Access Ramps into pool can create some awkward areas in terms of circulation in pools. Identified at design stage, the solution is simple as seen In the placement of three eyeball deliveries in the diagram below.



CONCLUSION

I have taken my fair share of the allocated time, and in reality this presentation has barely scratched the surface of this topic and is probably either off-subject, too detailed or too vague in terms of your particular interest.

I will therefore step back and field some questions.