Infrastructures & Water Works Unmanned Services

Infrastructure Type	Dam, Barrage, Bridges, Jetty, Port, water plants/intakes/outlets
Client Category	B2I, B2B, B2G
Client / Industry	Agricultural, Forestry, Environment, Irrigation, Public Works, Maritime and Transport
Type	Authorities, governmental institutions
Services	Infrastructure status survey/mapping
UST Technology	Combined UUV (ROV), and UAS (Fixed Wing , VTOL, Multirotor)

This infrastructure status survey consists in a snapshot and in-depth survey of the underwater and aerial infrastructure components and aspects of a given complex such a dam with a hydropower plant, a barrage for flood control, a bridge, using different UST according to the infrastructure environment and desired degree of investigation required.

The survey is composed of modules adapted to a specific type of infrastructure, as such it can be a multi survey module package or a single module. The former, for example, will provide the full site mapping down to each infrastructure component; the latter, will address a specific investigation aspect, for example the underwater infrastructure of a bridge, a water intake in a dam, or a building faced, or just the site map.

Each module is designed to identify potential structural defaults, moving parts conditions, underwater static sensor conditions, water intakes, specific parts, and/or assessing the structure after a natural disaster such as floods (assessing debris accumulations) and earthquakes.

For each infrastructural facility being reviewed, the survey includes two main components: aerial and underwater investigations. Each component is further divided in modules and specifics according to infrastructure type and environment. Components and modules can be selected all together or other combinations. Whilst the aerial investigations component is usually common to all type of infrastructure / sites including site mapping, building and above ground infrastructures; the underwater infrastructure investigation is specific to the type of infrastructural facility (dam vs barrage, bridge vs jetty, etc…).

For water body investigation/mapping please refer to Environmental Water Investigation Drone Solutions factsheet.

Aerial common inspection

Using appropriate UAVs, a flyover of the site allows quick identification of the status of the infrastructures with basic mapping. A first global mapping of a complex is often recommended as the base map to create a smart site and becoming the refence to be used in future regular or ad-hoc survey / monitoring.

- **Site Mapping:** Aerial infrastructures investigation comprises the mapping of the dam site area with all its infrastructure to create a 2D/3D map of the full plant. Using Unmanned Aerial Systems the mapping, orthomosaic, 2D and 3D mapping, will cover the full site infrastructure, identifying the overall works site to provide a snapshot providing detailed information with high resolution imageries of the full complex, each building and surrounding. The mapping can be used to create a smart site. The most common used technique is photogrammetry, however, thermal imaging and LiDAR mapping for specific requirements is also used.

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- **Building infrastructure inspection:** Using an UAV, buildings and infrastructures within the power plant and dam site can also be surveyed/investigated for structural aspect integrity, the surface conditions on the surface, using a variety of techniques (photogrammetry, LiDAR, thermal) according to the required outcome and in-depth survey; power tower inspections are undertaken using other techniques and tools.

Underwater common inspection

- **Visual inspection:** This is what we define as *"Eyes in the Water"* It is a simple operation using an entry level category underwater ROV with enhanced video and photography. This operation allows to see the underwater environment, inspect water inlet, water spout, waste water outlet. *Eyes in the Water* can be used to do a preliminary investigation to inform decision maker on other specific investigation and / or specific interventions, assessing beforehand the risk and the environment where specific response/survey ought to be carried out, saving time and money.

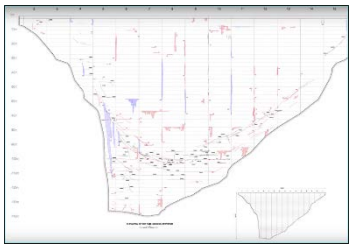
1. Dams (Hydroelectrical power plants)

The investigation of a hydropower plant comprises 3 main components: Aerial and underwater infrastructure investigations, water body survey. Each component has its own modules.

- Dam infrastructure inspection (arched dam): The dam infrastructure investigation comprise the use of both Aerial and Aquatic UST. This survey provided critical information enabling engineering departments to make an educated evaluation of the condition of the structure and identify the necessary intervention or non-intervention.

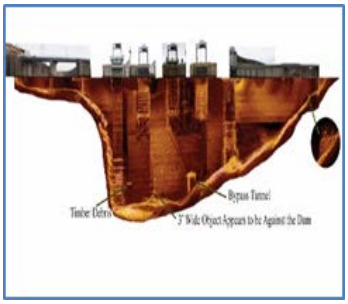
Aerial

The investigation consists of scanning the entire surface of the dry side of the arched wall using an UAS equipped with high resolution camera, and / or a LiDAR sensor providing a detailed image of the wall conditions. These techniques allow the identification of any anomalies present, such us wet areas, leakages and cracks which can be measured in 2 or 3 dimensions depending on the technology used. The images are reported in CAD providing a comprehensive mapping of the outside wall conditions; common technique used are mostly general photogrammetry and LiDAR.



Underwater

This technique allows the assessment of the status of the underwater infrastructure by visualizing the wall and if necessary mapping the structure itself. Using a specific underwater ROV equipped with specific sensors such as high-resolution video/photography camera, laser beam, and sonar a full scan of the underwater wall is achievable. While the use of only video capacity will provide a snapshot of the situation and photos of specific area, the sonar survey allows mapping of the entire wall surface. Laser beam are used to measure area of interest. Video capacity are ideal to inspect wall anomalies, accumulation of material on the wall or the bottom of the wall (e.g. sediments), inspect gates, intakes, fixed sensors, grid, outlets etc...



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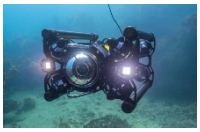
Aerial and Underwater

The combination of using aerial and underwater is of particular interest. External wall anomalies can be the symptom of an underwater conditions of the inner wall. Using both aerial and underwater UST for survey enable relevant authorities and engineers to evaluate the anomaly form both sides. If a full underwater scanning and mapping of the underwater surface is not required, using both technique (aerial and underwater) will result in a more cost-effective investigation process of the anomalies. The aerial survey allows for the spotting and location of anomalies on the outside wall allowing fast underwater survey by targeting only the area of interest rather than having to do a full scan of the entire surface.



2. **Earth and rock dams**

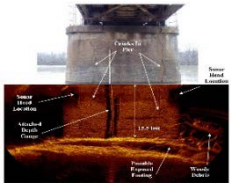
Underwater investigation on earth and rock of dam the focus will be on the underwater infrastructure from gates to inlet, grids and accumulation of debris on the inner side of the dam (water side) bottom wall.

3. **Barrages**

Underwater inspection. There are a variety of barrages and often they have in common the water gates to regulate water flows thus the investigation using different type of underwater ROV and sensors will allow for the visual inspection of the water gates, inlet, outlet and grid to the full underwater mapping using sonar technology. To enable this type of inspection there are limitation on the current speed and often require the closure of the gates and stopping the pumps.

4. **Bridges**

Underwater inspection Using a camera or sonar equipped ROV a full inspection of the pier allowing the assessment of the structure's conditions and accumulation of debris. The latter is a useful survey to be carried out after a major climatic event such as floods, mudslides, flash floods which often carry large amount of debris of different types which can accumulate on the bridge structures and pillars which may have caused damage that cannot be seen, unless an underwater survey is carried out. This type of survey can be combined with an aerial survey for a full infrastructure inspection.



5. **Water supply and water plants**

Underwater inspection of water supply and water works mainly consisted of visual survey using high definition camera equipped ROV's enabling a thorough inspection of the different underwater components of a water plant system such as pump intakes, grids, sensors etc..... Inside water tank to assess the health of the inner side (deposits, algae formations etc…) can also be assessed.

6. **Other infrastructures (jetty, pipeline, underwater sewers outlets, etc…)**

Underwater inspection by using camera equipped ROV's any underwater structure can be "visualised" to assess its conditions and growth of invasive aquatic fauna and floras, and /or any damages.

7. **General interventions**

Underwater intervention on infrastructures using specialized ROV equipped with high definition cameras, lights and robotic arms, some interventions such as removal of small debris from an intake are also possible.

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Aerial Business, Rates & Requirements

Description	*Where*	*Charge*	*Requirement*
Full service <u>No data analysis</u> (minimum acres/km applies)	In situ	Geographical area determined: acre/ km	Flight permit
Full service with data analysis	In situ	Geographical area determined: acre/ km	Flight permit

Notice:
Drone Solution Services Pte Ltd reserve the right to change, amend, cancel any part of its Aerial Business Services at any time without prior notice. The example above is purely indicative and strictly non-binding.

UAS model

Model	**DSS A300SD**	
UAS Type	VTOL	
Flight mode	BVLOS	
Endurance	180 minutes	
Range	30 Km	
Camera	Sony R*1Rm2 42Mp 35mm F2	
Flight Control	Ground Communication Systems	
Flight automation	Fully automatic	
Power	Lithium	
Safety	Low Battery protection, Geo Fencing RTL	
Payload	3.5 KG	
Customization for specific services/requirements		
LiDAR		Third party
NDVI		optional
Dual zoom camera		optional
IR / Thermal		Optional

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Aquatic Business, Rates & Requirements

Description	*Where*	*Charge*	*Requirement*
Visual inspection full service No data analysis (min tariff per day applies)	In situ	Service Type Dependent	Permits may be Required
Sonar inspection full service No data analysis (min tariff per day applies)	In situ	Service Type Dependent	Permits may be Required
Visual inspection full service + Data analysis (min tariff per day applies)	In situ	Service Type Dependent	Permits may be Required
Sonar inspection full service + Data analysis (min tariff per day applies)	In situ	Service Type Dependent	Permits may be Required
Robotic arm Infrastructure service	In situ	Service Type Dependent	

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ROV Models

Model	**DSS U100SD**
ROV Type/Use	Eyes in the Water
Speed	1.5 m/s
Endurance	4 hours
Depth	100 meters
Camera	4K, 12MP, MV4, JPEG
Live Stream	Yes
Navigation Control	Smart device
Navigation Type	Multidirectional
Navigation Automation	Motion lock, depth lock, 360°
Power	Li Ion Battery
Plug in Accessories	No
Safety	ROV breaking point 80 kg

Model	**DSS U200SD**
ROV Type/Use	Multi pass
Speed	2 m/s
Endurance	6 hours (depending on conditions and plug-in)
Depth	150 meters
Camera	Sony CMOS 1/2.3” 160°, 4K, 30fps, 12MP, MV4, JPEG
Live Stream	Yes
Navigation Control	Smart device
Navigation Type	Multidirectional
Navigation Automation	Motion lock, depth lock
Power	Li Ion Battery
Plug in Accessories	Robotic Arm (7 kg), Sonar, Hydrophone
Safety	ROV breaking point 300 kg

Notice:
The models shown in this factsheet are example of Drone Solutions UAS/USV/ROV listing. According to client requirement a different UAS may be offered / used.